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What Works in Adult Instruction: The Management, Design and Delivery of Instruction

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This report, a reprint of a special issue of the International Journal of Educational Research, is to provide summaries of research results for people who must design and deliver instruction. In the international industrial and military training community these individuals are mostly subject matter specialists not extensively versed in educational research. Thus, it is important for them to have sources of understandable, accurate and reliable information about "what works" in educating and training young adults. The basic assumption we make is that this information can be useful for instructional decisions and improve instruction. Individuals involved in instructional administration, design, or delivery can benefit from concise descriptions of factors that consistently improve student learning: What works. This document is meant to provide recommendations in an easily comprehensible form as a guide for instructional practice, evaluation, to help planning and policy making.

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Foreword

This research and development paper is part of a continuing effort at the Navy Personnel Research and Development Center (NAVPERSRANDCEN) to provide information developed under research programs in a form useable by Navy personnel. It was completed under Independent Exploratory Development Work Unit 0602936N.RV36I27.14 sponsored by the Technical Director of NAVPERSRANDCEN with funding from the Chief of Naval Research.

The objective of this work unit was to review and synthesize evidence from research on instruction and learning, to derive recommendations that may be appropriate to guide instructional practice in the Navy training system, and provide a document to be used as a resource for managers of training, for instructors, and for those who design and develop training.

The first document resulting from this work was published as NAVEDTRA 115-1 in September 1988. This version of the report was written during the last quarter of 1992, and was published as a Special Issue of the International Journal of Educational Research. It is being reprinted by NAVPERSRANDCEN for wider military distribution.

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WHAT WORKS IN ADULT INSTRUCTION: THE MANAGEMENT, DESIGN AND DELIVERY OF INSTRUCTION

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* The statements and opinions are the authors' and do not represent positions of the Navy Department or the Department of Defense.

PREFACE

RICHARD C. SORENSON* and HERBERT J. WALBERG†

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This summary of research findings about instruction and learning, provides practical help to individuals serving different roles in training and education. It represents a synthesis of the best available recommendations about instruction.

The training enterprise is large and costly. The investment of resources for training adults worldwide is significant. In the U.S. alone corporations spend more than $45 billion a year on formal training programs ranging from basic skills training to management training. This represents a 50% increase in five years (Tompson, 1990). In addition, Corporations spend a great deal on informal training such as "On-the-Job-Training." Billions more are being spent in military education and training where the need for highly trained personnel continues to increase in spite of reductions in the size of the Services. Complex technology requires highly trained personnel.

Over 20 million individuals participate in adult education programs in the U.S. A General Accounting Office study of U.S. federal government training programs indicates that the government spends $500 million each year to train approximately one in three employees. It is estimated that individual employees will need retraining five or more times during their "working lives." It is apparent that the task of developing and maintaining the instructional system is a large undertaking. Since we invest a large percentage of our Gross National Product in education and training, even minor improvements in instruction can result in substantial savings. The intent of the current effort is to improve instruction by making information about effective instructional practices available for use.

This document is intended to serve as a resource for (1) training managers/ administrators, (2) instructional developers or designers, and (3) instructors who are involved in adult education. The research summary statements have been grouped together in logical categories: Analysis, Design, Development, Presentation of instruction, Exploiting instructional technology, Evaluation and management of

instruction. As a result, the entire set of findings about adult training will not be of equal interest to everyone; the projected relevant topics for each user population are suggested by the matrix which follows the Introduction.

Over the last decade or so thousands of research studies have attempted to tease out which instructional techniques are most effective. Few people have the time to become familiar with the resulting literature. Therefore, attempts have been made to summarize the results and synthesize recommendations to guide instructional practices. This document has that intent.

As might be expected, some instructional techniques (variables) have been found to have a greater impact on student learning than others. The following list is derived from a summary by Walberg (1984) and by Bloom (1984), where many research studies were reviewed and combined to provide estimates of the size of the effect of different instructional strategies. Further, they are grouped according to whether the change is directed at the learner, teacher, materials, or home and peers. The size of the effect for each variable is shown in standard deviation units. It is the average effect size found in a number of comparisons. With an effect size of 1.0 units, the average student in a treatment group exceeded about 84% of students in the conventional instruction comparison group.

Table 1

Class	Variable	Effect size	Percentile equivalent
Learner	Corrective feedback, mastery learning	1.00	84
	Student time on task	1.00	84
	Student participation	1.00	84
	Improved reading/study	1.00	84
Materials	New curricula	0.30	62
	Advanced organizers	0.20	58
Home/Peer	Cooperative learning	0.80	79
	Intervention at home	0.50	69
	Peer group influence	0.20	58
Teacher	Tutorial instruction	2.00	98
	Reinforcement	1.20	88
	Cues and explanations	1.00	84
	Graded homework	0.80	79
	Peer tutoring	0.40	66
	Assigning homework	0.30	62
	Higher order questioning	0.30	62
For contrast	Socio-economic class	0.25	60

The research on learning and instruction has things to teach us about how students learn and therefore, about the organization of instruction and the nature of tests that would facilitate learning. The studies attempting to identify effective instructional variables led to the development of summaries describing "What works", intended to provide information for people broadly concerned with the organization of instruction. These summaries are intended as advice for implementing "good" practices in teaching, as well as summarizing research. For example, in 1986, Secretary of Education W. J.

Bennett published: *What works: Research about teaching and learning* directed primarily at parents and teachers of young children. A similar document: *What works: Summary of research findings with implications for Navy instruction and learning* soon followed, but focused on the needs of administrators, instructors and educational specialists who instruct Navy recruits (Montague, 1988). That publication was the result of surveying the extensive relevant research and then having the conclusions evaluated or judged by a panel consisting of W. E. Montague (NPRDC), F. G. Knirk (University of Southern California), J. A. Kulik (University of Michigan), M. D. Merrill (Utah State University), J. Orlansky (Institute for Defense Analyses), E. Rothkopf (Columbia University), T. Sticht (Applied Behavioral & Cognitive Sciences), and H. Walberg (University of Illinois, Chicago).

The current document focuses on adults, and is an extension and revision of the Navy document for a broader non-Navy audience of educators and trainers who are involved with adult education. It is addressed to educators involved in the delivery, management, planning, design, and development of education and training.

A basic assumption is that instructional content and methodology decisions make a difference, and that it is desirable to reduce training costs and improve effectiveness. Thus, individuals involved in training administration, design or instruction, can benefit from concise information about what research says makes a difference, *What Works*. Recommendations have been made based on the robustness of support from the research literature and the likelihood that changes can be made in teaching. They are stated in an easily comprehensible form to guide instructional practice, evaluation, planning, and policy making.

The information in this summary is a distillation of experience (panel of experts) and the research in education, military training, vocational education, and business training. We hope it is a useful distillation. We hope that instructors, training executives/administrators, instructional developers, and supervisors are willing and able to improve their own schools and education in general.

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INTRODUCTION

WILLIAM E. MONTAGUE* and FREDERICK G. KNIRK†

Overview of the Special Issue

The basic assumption behind this book is that current research on instruction, student learning, and performance has important things to tell us about how students learn and perform. Therefore, this knowledge can help with planning and organizing instruction, testing learning performance, and managing instruction efficiently and effectively. Often, those involved in planning instruction are unfamiliar with results from research that can guide instructional practices. These results are scattered through many journals that are not readily available, and articles often report results from individual studies that may be hard to interpret and are of unknown reliability.

The purpose of this special issue is to provide summaries of research results for people who must design and deliver instruction. In the international industrial and military training community these individuals are mostly subject matter specialists not extensively versed in educational research. Thus, it is important for them to have sources of understandable, accurate and reliable information about "what works" in educating and training young adults. The basic assumption we make is that this information can be useful for instructional decisions and improve instruction. Individuals involved in instructional administration, design, or delivery can benefit from concise descriptions of factors that consistently improve student learning: What works. This document is meant to provide recommendations in an easily comprehensible form as a guide for instructional practice, evaluation, to help planning and policy making.

This summary of research findings began as a project to provide recommendations to the U.S. Navy's education and training system to improve schooling, instructor training, and manager's training. Information was distilled from research and practice specifically geared to education and training in Navy schools. A group of expert advisors was used to assist in selecting the entries to be useful, and important for Navy education and training. Some of these advisors had been involved in analyzing and synthesizing research evidence, and others were involved in administering and managing schooling.

We examined how education and training was accomplished in the Navy, and identified three broad groups of users who play different roles in the training system. We examined

policies and practices to identify constraints under which the groups work. Then, we collected and reviewed the research literature to identify material relevant for the groups. Entries were included only when research evidence and expert opinion suggested they were stable and consistent. The difficult part of the effort was to translate the research findings into clear and comprehensible statements that we think can be used by users to guide their practices.

We developed a book, *What works: Summary of research findings with implications for Navy instruction and learning* (Montague, 1988), providing some of the most up-to-date reference information for the three broad classes of personnel that run Navy schooling. There are Training Executives who manage, administer, and supervise schooling at various levels. Instructors are mostly military personnel who are assigned as part of their job-rotation. They are briefly trained to be teachers, and are assigned as instructors for short periods (up to three years). Training Specialists are the third group. They provide educational advice and assistance to the other groups. They help with evaluation, course materials design and development. In general, these groups may have little formal training about instruction, instruction development, or management of instruction, although Training Specialists are likely to have some. The same classes of personnel are generally involved with teaching and instructional design and development in industrial and educational organizations.

The preparation of the Navy's book was motivated by a similar document produced by the Department of Education. That document, *What works: Research about teaching and learning* (Bennett, 1986), became the most widely distributed document on instructional research yet published. It was directed primarily at teachers and parents of young children attending public schools in the United States. In the Navy document and in the current volume, our primary concerns are the instruction of adults choosing practical careers rather than children.

Each "finding" was chosen in terms of the robustness of the research support, and its appropriateness for one or more of the groups involved in schooling. The references cited with each finding should be viewed as representative of the research evidence or for providing information on implementation methods. Thus, the information in this volume is a distillation of experience and a large body of scholarly research in education, military, and vocational education and training. It consists of discrete findings about teaching and learning that may be broadly applicable in focused, adult education and training classrooms, for instructional development and in planning how instruction will be done in the future. In some cases the findings may simply support what is current practice. In others, it may provide guidance to dramatically change current instruction or planning for future instruction.

The findings are organized into categories that correspond roughly to stages in the instructional design and development process. The use of systematic design procedures can make instruction more effective and efficient than it traditionally has been. A large-scale test of the effectiveness of instructional system design methods was its use to revise the elementary and middle school education system in the Republic of Korea. Students in the redesigned groups outperformed those in control groups in all school subjects by about 20% on average (Morgan, 1989).

At the least, all models of instructional design (and there are many, Gustafson, 1981) call for analyzing what is to be learned, specifying who is to learn, devising

instructional methods, and designing evaluation procedures to determine effectiveness and to provide checks on the process. The design models describe the process for designing and developing instruction. The intent is to allow designers to determine the best ways to implement the process. The process has considerable flexibility, and choices in instruction and evaluation are left to the skill and knowledge of the designer. Thus, the beliefs and knowledge (or lack) of designers and developers determine the way content is specified, the way instruction and evaluation of learning is accomplished. Since this knowledge should depend on evidence and theory from research, our intent is to provide research-based findings and recommendations to help with the design choices made.

Research Findings Seem Obvious

Many people find findings from social, psychological, and educational research "obvious" because they seem familiar and to be "just common sense" knowledge. But, what is called common sense is not common practice. An examination of schoolhouse practices reveals that the findings are not known, or go unheeded. For example, Latham (1988) concluded that training practitioners largely ignore results from the research literature. If the goal is to bring about application of practices that have been shown to improve student achievement, and ultimately, their job proficiency, some means must be found to overcome such ignorance and inertia. The fact is that *the feeling* that the recommendations are obvious is a common reaction. It promotes ignoring what is known in favor of convenience or habit.

In a recent paper Gage (1991) pointed out that the feeling that a research result is obvious common sense is untrustworthy. He described experiments where people were given statements to rate as obvious or unobvious. Each item either stated an actual finding on teaching, *or the opposite* of the true finding. Both true and false statements were rated obvious. Gage concluded that "People tend to regard as obvious almost any reasonable statement made about human behavior" (Gage, 1991, p. 15). Therefore, we suggest that generalizations from the research literature should not be dismissed as "trivial" or "known" information. Instructional practice is often contrary to recommendations derived from the findings, and improvements are needed to help increase instructional effectiveness. For example, the benefits of spaced practice have been known to researchers for 100 years, yet spaced repetition is not a major component of instructional programs (Druckman & Bjork, 1991). Properly applied, the information in this volume will assist the process but may have to overcome resistance.

The earlier versions of What Works have been evaluated by examining their usefulness for user groups. The concluding article in this issue, by Robertson and Whitehill, indicates the degree to which What Works conclusions have been used, and are trusted, by its users. It is interesting to note that respondents reported that they were already familiar with the findings. This observation is congruent with Gage's result. We doubt that this "feeling of knowing" truly represents the state of their knowledge.

Current Perspectives on Learning and Instruction

An understanding of learning theory is fundamental to instructional design and development. It influences objectives specification, testing, curriculum materials, evaluation and validity judgements. Managers, instructional specialists, instructors and developers all use a systems approach that encourages the close alignment of objectives, tests and curriculum materials. The learning theory which was embedded in the systems development approach when it was first applied to instructional development derives from behavioristic learning theory which requires the sequential mastery of constituent skills and behaviorally explicit testing of each step in learning. This model of "learn the sequential facts before understanding" has been contradicted by a substantial body of recent research in cognitive psychology (Shepard, 1991).

Several problems result from using this model to develop instruction. First, it leads to decontextualization of objectives, tests and material. The goal is to learn the declarative knowledge (facts, formal concepts etc.) of a particular subject matter (e.g., physics theory background for electronics), or general computational skills (e.g., algebra), rather than as information to be used (tool-like) to do practical tasks (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Brown, Collins, & Duguid, 1989). Secondly, the model assumes that component skills can be defined adequately, learned independently, and out of context. More advanced skills are learned by assembling component skills. This leads to delaying teaching higher order skills until after prerequisite skills have been mastered (Shepard, 1991). Also, this perspective leads to testing facts using various forms of objective tests (e.g., multiple-choice) without evidence for the correspondence between the cognitive processes involved in the test and the criterion performance. In addition, student's perspectives about learning goals are influenced by them being asked simple questions requiring recall or recognition of facts or procedures out of context. Seldom are they asked to describe how they would approach performing the task, which would be a preferred way of testing their practical knowledge.

Contemporary cognitive psychological research suggests that this model is inadequate. Studies find that things are easier to learn if they are learned in a context of use, when they make sense to the student. Learning is characterized by students taking in information, interpreting it, relating it to what they know already and when necessary, reorganizing their cognitive structures to accommodate new understanding. Students construct and reconstruct mental models or schemata that organize their ideas and inter-relationships. The situation in which knowledge is developed and used is not ancillary to learning or separable from it. It is an integral part of learning and cognition (Brown *et al.*, 1989). Thus, we recognize that learning requires a high level of activity from the learner. This needs to be supported by good teaching. Situational representations need to be devised that provide the context for use. R. Glaser portrayed how instruction should be organized to ensure learner activity:

> "When schema knowledge is viewed as a set of theories, it becomes a prime target for instruction. We can view a schema as a pedagogical mental structure, one that enables learning by facilitating memory retrieval and the learner's capacity to make inferences on the basis of current knowledge. When dealing with individuals who lack adequate knowledge organization, we must provide a beginning knowledge structure. This might be

> accomplished by providing overt organizational schemes or by teaching temporary models as scaffolds for new information. These temporary models, or pedagogical theories, as I have called them, are regularly devised by ingenious teachers. Such structures, when they are interrogated, instantiated, or falsified, help organize new knowledge and offer a basis for problem solving that leads to the formation of more complete and expert schemata. The process of knowledge acquisition can be seen as the successive development of structures which are tested and modified or replaced in ways that facilitate learning and thinking." (Glaser, 1984, p. 101.)

The analysis of tasks to be learned needs to reflect these ideas and the ideas are often at odds with traditional ways of objective specification and designing tests to measure progress and facilitate learning.

> "Tests ought not ask for demonstration of small discrete skills practiced in isolation. They should be more ambitious instruments aimed at detecting what mental representations students hold of important ideas and what facility students have in bringing these understandings to bear in solving new problems." (Shepard, 1991, p. 9.)

The goal of instructional design and development is to engineer conceptual growth and understanding. Instruction should center on the student's attempt to construct understanding. It should be devised to support the student's attempts to interpret, structure or restructure, and use new knowledge, as opposed to the memorization and verbatim reproduction of information. Instructional environments that foster learning, encourage questioning, evaluating one's own and others' performance, and critiquing the performance process.

Objectives and tests ought to have the goal of capturing in the test tasks the same requirements for cognition and knowledge integration as required in the criterion performance desired. Tests serve to assess a student's understanding, but also are important instructional tools. To convey to students that their reasoning is more important than choosing a correct answer, we might ask them to show how to set up an approach to a task, to explain a point to another student, or to plan a route to get from point A to point B. This can be thought of as *authentic* testing.

The notion of using authentic, direct performance assessments in testing is repeated in recommendations for instruction. Instruction should be centered around authentic task practice situated in a context of use (Gott, 1989). Students are to be taken through successive approximations of mature practice while learning to perform specific tasks. The method is referred to with several names, "cognitive apprenticeship" comes closest to being descriptive (Brown *et al.*, 1989). Cognitive apprenticeship supports learning in a domain by providing authentic domain activity, allowing students to experience the full functional context. The student learns, develops and uses the cognitive tools appropriate for the domain. It is similar to, but less resource demanding than, traditional craft apprenticeship since it is intended to be useful in schooling.

The term "apprenticeship" emphasizes the importance of "...activity in learning and knowledge and highlights the inherently context-dependent, situated and enculturating nature of learning" (Brown *et al.*, 1989, p. 39). It also suggests that to promote student learning, instructors must make their own tacit knowledge explicit, and model how to perform the task. Then, the instructor has the student perform independently and offers hints, feedback, reminders, or redirects the student's attention to salient features.

The goal is to make the student's performance approximate the expert's as closely as possible. The word "cognitive" means that apprenticeship is more than the physical skills usually connected with it. The apprentice must learn to reason, speak, and act like a practitioner.

Research programs investigating practical skill learning have thus led to a change in the understanding of processes involved in learning and performance. They have changed our perspective about how instruction in practical tasks should be done and how student progress should be assessed. Rather than identify task components and teach them out of context, the advice is to teach in the task context providing support (advice, cuing) for students so that they can build realistic experiences. We have attempted to incorporate this perspective into the recommendations that follow and to the summary findings that form the body of this document.

Communications/Computer Technology can Help Instruction

The performance orientation of the prior discussion implies that instruction and testing learning performance will involve simulation-like, authentic, representations to mediate student learning. Obviously, new communications and computer technologies can be used for such simulations. The increasing availability and declining costs of this gagetry and its popularity will ensure that it will be used in education and training. We are worried that use of the technologies will occur without careful, systematic effort to incorporate what we know about learning principles to promote effective learning and performance.

The role of the designer of instruction is to provide the learner with the necessary tools and conditions for learning. The student needs to acquire the appropriate language and concepts to be used to understand and describe situations in which what is learned is used. The student needs to learn how to put the information, facts, situations, and performance skill together in appropriate contexts.

Competent performance of complicated tasks develops slowly, and requires an environment that supports the development of subskills, knowledge and their coordination. Anyone attempting to design and develop instruction has a substantial orchestration problem on their hands. It requires analysis of competence or skill and breaking it into manageable and appropriate chunks for students to learn. Providing a learning environment requires considerable sophistication and skill for using resources. It also requires understanding the uses to which competencies can be put. An attractive feature is the use of technology for representing task situations to students realistically. Representing cases, situations, scenarios, and simulations, to approximate actual task performance conditions requires technological assistance and considerable resources.

Computer and modern communications technologies can help in various ways with the preparation of instruction and its use. For example, in the design and development stages of instructional preparation computer-based tools can assist with the analysis of tasks, and planning instructional sequences. Authoring systems can aid preparation of instructional materials and coordinating related segments of instruction that may need frequent revision.

Technology is likely to aid the delivery of instruction in various ways. Access to

instruction can be increased using modern communications technology. The "Open University" idea has worked well for years and the technology can help remove barriers to education and training. From the distribution side, technology can provide widespread delivery of presentations at remote locations at varied times. Forms of individualized learning have proven highly effective and some of these forms can be implemented broadly using computer-based and video technologies.

Providing learning environments that are functionally equivalent to target work/application situations will need the assistance of technologies, both from educational design as well as computer/communication technology. But, these "requirements for realism" are costly to implement, requiring special skills.

The evaluation of the adequacy of instruction as well as student progress toward competence can be aided by use of computer/communication technology. Thus, there are many ways in which technology can assist the instructional process. This has been recognized for many years. To make effective and efficient use of technology requires systematic planning and assessment, which does not happen often, or easily.

The Office of Technology Assessment (1988) said "A more focused effort to expand substantially the use of technology in education and attain more fully integrated applications across the curriculum will probably require new strategies ... " (p.5). Due to the importance of these instructional technologies a final section in *What works* summarizes what we know about their use for adult training.

The Office of Technology report (1988) supports the use of instructional technologies in the classroom. It says "By and large, the research to date supports the continued use of instructional technologies in the schools . . . there is evidence that computer-assisted instruction can raise achievement test scores for some students; but there is also wide agreement that computer technologies can already do more than provide electronic equivalents of drill and practice workbooks, and that much of their future promise lies in experimentation and development of nontraditional learning methods" (p. 42). Computer-based systems may assist in implementing the authentic instruction discussed previously. Sophisticated uses of technology such as this, however, require considerable expertise in program development and substantial changes in the instructional system as a whole.

Training managers can use this technology to make them much more effective. The Office of Technology Assessment (1988) looked at these communications technologies as follows: "OTA finds that investments in technology cannot be fully effective unless teachers receive training and support" (p. 16).

> "OTA finds that software manufacturers tend to play it safe. They produce what (will sell) and teachers usually buy products that are familiar. The potential result is a relatively homogeneous set of products that fall far short of the possibilities provided by the new learning tools" (p. 22).

In an effort to assist the different categories of readers (training managers, instructional developers, and classroom instructors) to the most appropriate materials, a "What Works: User Matrix" has been constructed. The matrix follows this introduction.

The potential for technology to increase the quality, effectiveness, and efficiency of education and training depends on careful design and careful implementation. Neither

is easy. In spite of adoption of systems design procedures, the development and management of instruction is quite variable. The procedures do not make up for deficits in the skills needed to devise quality instruction. Computer-/communication-aids may help, but they need to be developed and made available broadly to have any significant impact. Their development will require significant resources that are currently in short supply. In addition, although some gains might be realized by implementing computer-based and other technologies, the gains are realized only when the way schooling is done changes. The way instructors are utilized and schoolhouses are managed needs to change to accommodate the technologies. It seems likely that technology will gradually be adopted to help the process, and unlikely that it will change things radically.

Role Descriptions for Training Practitioners

An analysis of the tasks of instructional personnel coupled with relevant research led us to develop the following list of suggestions. This is an attempt to focus attention onto certain aspects of their roles and responsibilities to assist in coordinating the roles with recommendations from research.

Managers/Administrators

- Become assertive instructional leaders by putting instructional excellence first.
- Bring instructional technology and good practices to bear on instruction.
- Demand high quality in training from staff, instructors and students.
- Develop and monitor in-service staff training.
- Establish a system for evaluation and monitor it systematically.
- Promote a positive climate and overall atmosphere.
- Focus programs on instructional goals and protect them from irrelevant demands.
- Encourage consensus on values and goals.
- Plan and coordinate long-range changes in training to increase effectiveness and efficiency.
- Analyze and plan for use of instructional technologies to increase training productivity due to informed media, and class size decisions.
- Consult with training specialists about training policy and practices.
- Provide human factors controls in classrooms so instructors can direct attention and learning via light, color, temperature, and noise control.

Instructional Developers

- Learn and understand scientific bases for training excellence.
- Become assertive instructional leaders by emphasizing factors that bring about excellence.
- Expect high quality and productivity from staff, instructors, and students.

- Implement and monitor in-service staff training.
- Monitor and evaluate instructors, and instruction.
- Promote peer interaction among instructors.
- Protect instruction from irrelevant demands.
- Develop a well-structured, work-like training environment to support student learning.
- Adjust training to goals and to learners through detailed evaluation of performance.
- Assist instructors in providing feedback to students.
- Monitor development and empirical evaluation of training technologies.
- Analyze and propose improvements in training effectiveness and efficiency.
- Provide input to higher management regarding training policy.

Classroom Instructors

- Bring good practices to bear on training.
- Focus classroom activities on learning.
- Emphasize student learning and achievement.
- Monitor student studying and adjust their activities to maximize their effort and progress.
- Promote effective use of instructional time in learning.
- Learn teaching techniques that enhance student learning.
- Provide well-structured presentations and classroom activities.
- Arrange many and varied learning opportunities.
- Create a job-like instructional situation.
- Emphasize hands-on, job-like performance tests.
- Use testing and questioning to evaluate learning progress and maintain motivation to learn.
- Give corrective feedback regularly.
- Provide students with opportunities for individualized work.
- Design out-of-class assignments to increase student achievement.

Instructional Personnel can Exploit Instructional Hardware and Software

- Learn the basis for ergonomic principles and guidelines involved in designing educational equipment and furnishings.
- Become assertive instructional leaders by not settling for communications equipment developed for non-educational uses, and require communications equipment which facilitates good learning and perception principle implementation.
- Expect high technical and design quality in all courseware (films, video programs, computer software, etc.).
- Monitor development and empirical evaluation of training hardware and software technologies.

Summary Statements

In the main body of this document, "findings" and modifying "comments" about each of the what works topics are presented. A finding presents a generality about an instructional practice variable that falls in one of the stages of instructional design. The comments provide explanation and reference information about each finding. The items represent heuristic guidance to assist designing instruction, and can also be used for evaluating practices to detect deficiencies. We are not sure about the effects of combining effective instructional variables. Presumably, the combination will increase the benefit for student learning. But, some combinations will likely have uncertain, or even negative, effects on student learning. Skill in using this sort of information is sure to be developed through experience. Thus, the findings provide general statements about what factors have been found to affect student learning. Their use in practice, will be determined by constraints on resources and people.

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Table 2
What Works: User Matrix

	Managers	Designers	Instructors
Analysis			
1. Training objectives	M	H	H
2. Training analysis provides course objectives	M	H	M
Design and development			
3. Focus on post-training performance	M	H	H
4. Refresher training	M	M	H
5. Increasing time on task	M	H	H
6. Distributing practice in time	M	H	H
7. Development of mental models	L	H	M
8. Learning is based on prior knowledge	L	H	M
9. Motivating students	L	H	H
10. Cooperation in learning	L	H	M
11. Situated teaching and learning	L	H	M
12. Student control of learning	L	H	H
13. Writing text materials	L	H	L
14. Readability of training materials	M	H	M
15. Memorization aids	L	H	M
16. Using examples and nonexamples	L	H	M
Presentation of instruction			
17. Instructor classroom leadership	L	M	H
18. Instructor classroom role	M	H	H
19. Teaching students how to learn	L	H	M
20. Instructor presentation stimulates learning	L	H	H
21. Practice	L	H	H
22. Peer teaching	L	H	H
23. Listening skills	L	H	M
24. Homework assignments	M	H	H
25. Testing student learning	H	H	M
26. Giving feedback to students	L	H	H
Exploiting instructional technology			
27. Cost effectiveness	M	H	L
28. Programming instructional presentation	M	H	L
29. Programmed instruction materials	L	H	H
30. Computer-based instruction	M*	H	M
31. Hypertext-based instruction	L	H	L
32. Visual representations for learners: television/interactive video/VTT	M*	H	M
33. Simulations and simulation games	M*	H	M
34. Distributed instruction	L*	H	L
35. Job performance aids	L	H	M
36. Adopting training innovations	H	H	L
37. Designing effective illustrations and graphs	L	H	M

Continued

Table 2
(Continued)

	Managers	Designers	Instructors
Evaluation			
38. Criterion referenced testing	L	H	M
39. Course evaluation and revision	H	H	H
40. Evaluating and supervising instructors	H	L	L
Management of instruction			
41. Planning change within organizations	H	M	L
42. Managing instructors	H	L	L
43. Managing student learning	H	H	H
44. Monitoring and tailoring instruction	L	H	M
45. Physical classroom environment	M	H	M
46. Managing informal learning	L	M	M
47. Student–instructor ratio tradeoffs	H	H	M

H — This topic will be of high interest to this audience; M — This topic will be of medium interest to this audience; L — This topic will be of low interest to this audience; * — These topics need to be considered by course managers because of the high initial costs for hardware acquisition and/or software development.

FINDINGS MATRIX:
WHAT WORKS IN ADULT TRAINING

FINDINGS ABOUT THE ANALYSIS OF INSTRUCTION

The design of instruction can be viewed as a problem-solving process, a way of solving instructional problems. The first steps in the process are analytical: Determining whether training/instruction is needed; analyzing what must be learned, by whom, and specifying the goals and objectives that serve as the focus for organizing instruction and evaluation.

1. Training Objectives

Finding: **Instructional objectives reflecting the instructional requirements directly guide instruction and testing and thus student learning.**

Comments: The use of measurable or observable instructional objectives helps ensure consistency between what is learned, course content, and test items. This consistency or congruity reduces the amount of irrelevant course material, and objectives can assist student learning.

When materials include the objectives, learner confidence improves and learner anxiety decreases. Including objectives seems to be more effective in courses involving difficult text materials than in courses with easier or more understandable texts.

While objectives may be easier to write for instruction focused on specific, concrete tasks than for more academic content areas such as history, no evidence suggests that objectives are more useful for one content area than another.

Expanding the task statements that require instruction into objectives dictates specifying how the learner will show learning, identifying the relevant conditions under which the behaviors are to be exhibited, and specifying standards used to specify adequate performance.

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2. Training Analysis Provides Course Objectives

Finding: **Training needs analysis and task analysis yield objectives that serve as the basis for testing and designing instruction.**

Comments: Course effectiveness and efficiency depend on the consistency between the training requirements, implied task requirements, objectives, task statements, and how instruction is presented.

The quality of a training program depends upon the adequacy of course objectives. Given an adequate analysis of training requirements, then it is possible to develop a relevant course and adequately test its students.

Reviews of adult training courses reveal mismatches between required skills and the objectives indicating inconsistency. Objectives are often misused in the design or presentation of the course materials. Irrelevant information may be presented. Required information, as reflected in the objectives, is too often missing from the course materials.

The objectives determine what the curriculum and testing should contain. Training requirements and objectives often specify one sort of performance as a goal of learning, but another is tested. For example, the objective "Given the weight of a thawed raw fowl, and depending on whether or not the fowl is to be stuffed, the student will determine the optimum cooking time at 325°F to within three minutes" cannot be tested by tasting the bird, nor having the student recognize the answer on a true-false test. The objective requires the calculation of an answer. Thus, a short answer test, or fill-in is the best test for this objective.

To show the extent of the problem, in an extensive study of Navy technical training courses as many as 56% of the training objectives were found to be inappropriate. A major reason is that the required

training standards are inappropriate; half of the objectives were not tested; less than half of the test items matched the objectives. These courses can obviously be improved as, probably, can most courses.

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FINDINGS ABOUT THE DESIGN AND DEVELOPMENT OF INSTRUCTION

Once objectives have been defined for a course or lesson, a systematic instructional design procedure requires designing and developing the presentation and management of instruction. Analysis and classification of the objectives is needed to reveal the cognitive operations involved in performing the required tasks. Classification then aids in determining how to instruct. Analysis indicates essential and supportive training design and development requirements. The summaries that follow are intended to assist this process.

3. Focus on Post-training Performance

Finding: **Conditions that yield rapid learning and good test performance may produce poor post-instruction performance and transfer.**

Comments: The main objective of instructional programs is to prepare students to be able to perform effectively on some task in the real-world. However, having learned to perform a task in school does not guarantee performance months later, in different context(s). Yet, those responsible for instruction usually see only performance of the learner during instruction, not on the real-world task(s). Thus, they may focus on making learning efficient at the cost of later performance.

Procedures that enhance performance during instruction may not enhance retention or performance in different contexts. On the other hand, procedures that introduce difficulties for the student, impairing performance during learning, can result in durable and adaptable post-training performance. Performance during instruction may depend on rote memory, or cues specific to the learning context rather than substantial, durable, learning.

Thus, the effectiveness of instruction should not be measured primarily by how fast students learn, or by the level of test performance at the end of instruction. Instead, performance on the post-training tasks in real-world settings should be used. To ensure more adequate testing, tests of a student's progress during instruction should measure performance as it will be measured on the real-world tasks in the real-world setting.

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4. Refresher Training

Finding: **Systematically planned and monitored real-world repeated testing and rehearsal of critical skills is required for maintaining those skills.**

Comments: Everyone loses trained skills and knowledge during extended periods without specific exercise or practice. Extended periods of nonuse are common in many real-world situations.

Most adult training is considered complete when students have acquired minimal competence. Partly this happens to keep costs down. Presumably, the students are expected to develop proficiency on the job. However, many tasks are rarely exercised. Therefore, procedures to maintain competency should be made part of performance requirements. If this can't be done, methods to strengthen the original learning might be implemented in training. These methods may lengthen the training period, and thereby increase costs. If refresher training is unfeasible, as where errorless performance is needed in emergencies, original learning might have to be carried to a considerably higher level.

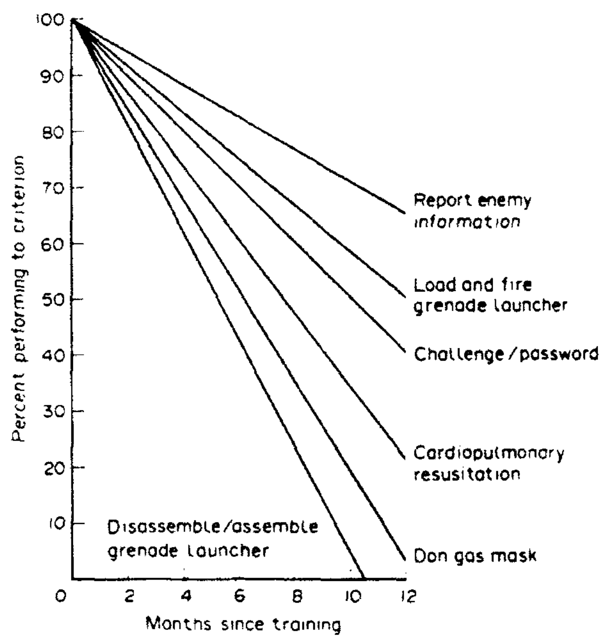
Considerable evidence shows that attention to rehearsal of rarely used skills is often lacking. For example, Army researchers found that few soldiers who performed basic soldiering tasks adequately after training could perform them adequately after a year in the field. (See the example below.) Apparently, they had not performed or rehearsed most of the skills during the year. Analysis of conditions in the Navy also reveals occupations in which sailors do not practice the new skills for long periods. Such lapses promote skill and knowledge losses, not their improvement. Thus, systematic management of skill maintenance is needed to maintain competence.

There is no way to make accurate, quantitative predictions about the rate of skill loss, how fast relearning occurs, or how often retraining should occur. What is known is that initial learning during training must include the maximum amount of practice possible under conditions that approximate the performance situation, and that successive retraining or exercise sessions are needed at spaced intervals. Time management during initial training must ensure that time allotted is used for practicing the skill and not for irrelevant activities such as waiting for equipment or watching others perform.

One suggestion is to base the spacing of refresher practice sessions for novices on how often journeymen perform the skill or task. For example, if journeymen perform a task monthly, rehearsal spacing of about a month might be advisable for novices.

In cases where rehearsals are difficult or too costly to arrange, more than minimal learning should be provided during the original course. The main point is that planning and scheduling the rehearsal of critical skills is mandatory.

Example: Without systematic refresher training, performance of procedural skills declines rapidly after training. The following figure taken from Hagman and Rose (1983) and Shields, Goldberg, and Dressel (1979), depicts the decline in the number of soldiers able to perform basic soldiering tasks adequately after training. The rate of skill loss differs for different tasks, perhaps due to the varying number of steps in each procedure. In any case, the decline suggests the need for providing systematic practice to maintain skills.



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5. Increasing Time-on-Task

Finding: **Other things being equal, providing supplementary time for practice increases the level of achievement.**

Comments: One of the simplest ways to increase student achievement is by providing more productive time for learning. Simply allocating time is not sufficient, the students need to be actively and productively engaged in relevant study. This may be done by providing a variety of learning or practice opportunities. If training periods are excessively long however, there may be diminishing returns for additional training time; the students may become "burned out" and accomplish the same amount of learning in less time.

Although there is a positive relationship between the amount of time the students spend on their learning tasks, the achievement gain is modest compared to peer-tutoring and other strategies for improving achievement.

There are several consistent findings which have emerged from the study on instructional time:

- Time is a scarce resource — students must have time and the opportunity to learn.
- Time is overlapping on tasks and not mutually exclusive; two or more activities can occur simultaneously and independent measurement of conceptually separate variables is difficult to interpret.
- Observation and interpretation of a student's time-on-task and the time a teacher spends teaching the task may confuse different

processes. A student may receive direct instruction relevant to the objectives and also receive indirect instruction on them while the instruction is primarily oriented toward loosely-related objectives. Thus, it is difficult to assess time-on-task or instruction time on either set of objectives.

- Time-on-task is not the same as time on the right task.
- Allocated instructional time on a task is not the same as engaged time.

It appears that all other things being equal, the amount learned is generally proportional to the time spent in learning. Walberg (1988) found that 30 out of 35 studies showed a positive association between learning performance and time spent learning.

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6. Distributing Practice over Time

Finding: **Spacing practice over several sessions separated by periods of unrelated activities yields better performance than equal amounts of massed or concentrated practice.**

Comments: For a fixed amount of practice, learning is better if practice is distributed in time. This is generally true if learning is measured by performance on a later retention test. If learning is measured during instruction, massing practice yields better test performance. Since instruction intends to optimize performance over the long-term.

this finding shows that performance during instruction may be an unreliable indicator of learning. Sometimes massed practice yields long-term test performance less than half that which results from spaced practice. This effect, that practice spaced in time results in superior long-term performance than massed practice, is one of the most dependable findings from learning research.

Learners can absorb and integrate only a limited amount of new information at one time. Training can be made more effective by designing shorter lesson segments, and distributing them in time by separating them with periods of other activities. Both non-training or different training activities can be interposed between scheduled sessions. For example, five classroom hours of lessons on quality control procedures will be learned best if they occur on five successive days, rather than all on a single day.

Similarly, repetition of drill needed for developing skills can be made more effective by using short sessions separated by other drill activities. If, for example, trainees are learning code recognition, separating short blocks of practice trials by practice on other tasks or activities is more conducive to learning than when the practice is massed together.

Two "spaced" or distributed sessions are about twice as effective as two successive or massed sessions, and the difference between them increases as the number of repetitions increases. Achievement following massed practice sessions is often only slightly better than that following a single, shorter session. Massed presentations may be unnecessarily repetitive and result in learner boredom. One reason for spacings' efficiency may relate to the learners being more interested in material the second time they are exposed if the repetition occurs after some delay.

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7. Development of Mental Models

Finding: **When students learn to act in accordance with a prescribed "model" of performance, they develop conceptual understanding that guides competent performance more effectively.**

Comments: Learning occurs by the learner's active construction of schemas or conceptual structures that are called "mental models." Learners *construct and then reconstruct* mental models that organize ideas and their interrelations. A person makes use of an internal model of the world to understand, explain, and predict things about the world. If people carry a small-scale-model of external reality in their heads, they are able to try out various alternatives, can decide which is the best of them, react to future situations before they occur, utilize knowledge of past events in dealing with the present and future. Models allow people to generate descriptions of system purpose and form, or explain system functioning and observed states, and to make predictions of future states. These models provide a means for organizing and reorganizing memory and deciding on actions.

Mental models evolve naturally through the interaction of the learner and particular environments. They are intimately involved even in elementary reading, mathematics, and other school subjects. The traditional view that basic subjects can be taught as routine skills with thinking and inferencing to follow later, provides a poor guide for instructional practice.

Unfortunately, models developed by students are often incorrect and lead to errors. Students can be aided to develop effective mental models by providing them with structured experiences (such as learning to troubleshoot), by presenting functional representations of systems (such as Kieras' device models), or by suggesting analogies

(such as the "water through a pipe" analogy for electron flow). Instructional developers and instructors can devise methods to help students promote the development of effective models. Instructors may work with students to study how their model systems work and then assist the student to correct inappropriate models.

Students may be helped to develop models which represent the functionality of the work environment, and the devices/equipment in it. Providing external guidance or directions, i.e., telling what to do and how to do it, allows the build-up of experience coupled with important cognitive information that, once internalized, will guide performance. An accurate mental model develops from the way events flow on-the-job, how devices function and can malfunction, and serves as the scheme to guide personal action when new problems are encountered. Having students describe in detail the steps they're using while performing, identifies errors and competence develops faster and transfers readily to the work environment.

As an example, take the task of training students to solve problems in electric circuits, thermodynamics, or mechanics. By guiding them through the steps, and explaining why they're taken, and then having students describe the factors and their interactions as they solve subsequent problems they learn rapidly and accurately. Instructors can check the accuracy of a student's initial representation and provide feedback. It focuses students' attention on the need for careful representation of all facets of the problem, and provides the basis for correct solutions. Thus by concentrating on accurate initial description of the problem, students learn to internalize the procedures as part of their mental model, and use it habitually in approaching problems later on.

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8. Learning Based on Prior Knowledge

Finding: **Students learn best when instruction is adapted to the students' existing knowledge and background.**

Comments: Learning is a process whereby students take information, interpret it, connect it to what they already know, and if necessary, reorganize their mental models to account for the new findings. When dealing with individuals who lack adequate knowledge organization (mental models), we must provide an initial or beginning knowledge structure. This may be accomplished by providing explicit organizational schemes, or temporary models, that serve as scaffolds for new information. They form the basis for organizing new knowledge, and provide a basis for problem solving.

Students begin learning new information and concepts with a great deal of prior knowledge. Good instruction is aimed at eliciting this prior knowledge and explaining the congruence or misfit between what is to be learned and the initial conceptions. Learning progresses from simpler mental models to more complex ones. Instructional materials need to be designed to take advantage of the student's entering or existing knowledge and experiences.

Any assumed prior knowledge or skill for a learner that is found not to be in place at the time of instruction, must be taught explicitly at that time. The time, cost, and trouble of preparing students for the intended activity must be included in the course costing.

Structural knowledge enhances retention of the subject matter, facilitates problem solving, and leads directly to transfer to similar and (perhaps) new situations. Structural knowledge may also result in intellectual excitement and an aptitude for learning.

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9. Motivating Student Learning

Finding: **When instruction gets the learner's attention, is perceived as relevant, as having attainable goals, and provides frequent testing and explanatory feedback, students persist in learning, achieve well, and enjoy learning.**

Comments: There are many factors that influence student motivation to learn and determine their achievement. Techniques that make the learner persist in learning, and bring the learner into more persistent contact with the information or tasks to be learned, improve performance. Instructional design goals to help accomplish this are to: make learning interesting, help students set learning goals, promote student tolerance for making errors while learning, and provide specific feedback to guide students toward mastery.

Instruction that is attractive and exciting is useful to gain students' attention or interest. Therefore, the design of instruction would attempt to stimulate students' curiosity by including incongruous, or novel, or attractive material that would make them eager to engage or study the material.

Students' understand the relevance of instruction when objectives are explained to them and new learning is related to their past experience and knowledge. Presentations need to explain the goals of the instruction, how the knowledge is to be used, and the role the learner will play in the real-world when learning is finished. The students should feel the instruction meets their personal needs or goals. Providing instruction that allows students to proceed through a sequence of graded steps increasing the likelihood of success develops confidence in their ability to succeed.

Students can learn to set daily training goals, monitor their progress toward these goals, and chart their progress to provide their own reinforcement. Instructors should ask their students about their progress toward these goals and then provide positive verbal encouragement and reinforcement.

If students fail to solve learning problems, they tend to reduce effort expended in learning. Segments of instruction need to be arranged to build students expectation that they can achieve the course goals with sufficient effort. Thus, presenting simpler materials and problems first, arranging objectives in a progressive, logical sequence, and other techniques that enable correct actions or explain what adequate behavior is like, all motivate learning. Student control of the pacing through the steps sometimes seems to increase learner confidence.

Providing students with feedback explaining the adequacy and inadequacy of tests of learning and social rewards for expended effort influences student satisfaction. If the instructor can establish a trusting relationship with the student the feedback is valued and sought. To stimulate student satisfaction, praise for accurate performance, and informative feedback work better than threats or negative comments. Feedback following soon after performance should emphasize what is or was acceptable about the performance. Information correcting errors or guiding performance may be most useful given just before another opportunity to perform.

Instructors need to provide meaningful opportunities for the students to use their newly-acquired knowledge and skills. Instructors should make their grading and performance requirements consistent with the expectations (criteria and standards) as stated in the objectives. Extrinsic rewards, such as grades, scores, and points, while necessary, may not motivate students as well as goals and rewards based on direct involvement with the ongoing training. Focus student attention on long-term competence rather than extrinsic rewards. Instructional developers need to develop training materials which are authentic, life-applicable, holistic activities instead of activities involving information recognition or retrieval, repetitive seat work, or isolated practice exercises. Developers also need to keep motivational materials relevant to the course objectives.

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10. Cooperation in Learning

Finding: **Students who help each other and work together learn more than when they study alone.**

Comments: Organizing students into small groups (of 2–3 students) to study improves their performance on achievement tests. This arrangement promotes positive attitudes of students toward each other and toward learning and school. It has potential to assist team training. Group work allows students to observe, imitate and learn from each other, keeping each other on task and sharing accomplishments. It is important to make sure that one student does not dominate the others, thereby limiting their opportunity to learn. This can be achieved by instituting procedures that make sure that each student spends an appropriate amount of time actively learning.

Peer cooperation can take a variety of forms: Discussion groups, seminars, or tutorial groups led by teaching assistants; the proctor model, where senior students may assist individual students; student learning groups that are instructorless or self-directed; or senior students teaching entering students. Arranging peer interaction in

small groups to supplement regular classroom and laboratory teaching often helps slower and underachieving students to learn and succeed in their learning.

Students coaching students raises their achievement. Coaches benefit because they learn more about the material by preparing and giving lessons to others. The effects are greatest in long academic courses and extensive drill and practice courses. Short courses that stress test-taking show the least improvement from coaching methods. Classes that use tests at the start of the course report stronger coaching effects than classes giving tests only at the end.

Students bring many life experiences into the classroom, which should be acknowledged, tapped and used. They can learn well — and much — through cooperative study with respected peers.

Students tend to avoid activities that they believe will result in failure. A competitive situation arouses the need either to achieve success or avoid failure. Encouraging cooperation, rather than competition, among students promotes more effective learner achievement and productivity. Students competing for grades or other extrinsic goals focus on beating other students rather than on understanding the course material and learning how to work as a team member.

Studies of students using computers for instruction, show that students learn at least as well when paired at a computer as they do by working by themselves. Learner attitudes toward their class-mates also improves when they are paired. Cooperative learning promotes positive feelings of personal worth and positive attitudes toward the course content.

Simply grouping students to work on a learning task does not ensure that cooperative learning occurs automatically. Providing students with a certain amount of structure increases the liklihood that they will work together in a way that contributes to their learning.

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11. Situated Teaching and Learning

Finding: **Learning knowledge in a relevant context motivates learning, assures that it is usable, and enables skillful performance of the task in the real world.**

Comments: Often, students who have demonstrated that they know the schooled facts and concepts, fail to use the facts and concepts on appropriate occasions. This occurs even in technical schooling. What is taught in schools resembles *unique school activities* rather than activities useful for performing practical tasks. To ensure the usefulness of schooled knowledge, instruction should be focused or situated in a context for experience rather than be taught as abstract knowledge to be applied later. *Experience* includes both the physical context in which a student's learning is to be used, and the tasks, both cognitive and physical, that the student engages in while in that environment. Instruction should involve the same operations, the same tools, and the same machines (or their functional equivalents) as the practical situation.

Situated teaching emphasizes the role of the teacher as an expert practitioner who models skilled performance for students and interactively guides the development of students' competence by coaching. What students learn is focused in both the external and internal aspects of the context, and can be thought of as a

specific activity within a specific culture. The closer instruction is to actual technical performance in terms of task-related specificity, completeness, and realism, the greater its effectiveness. Instruction should be guided by level of competence expected in the practical situation. If a student will be closely guided by others (e.g., a supervisor), then the instructional program should not expend the time and effort to graduate students who need no guidance. Effective management of instruction matches the level of instruction with expected conditions of performance.

It seems likely that, in most cases, schooling will be able only to *approximate* the authentic target context. Various forms of representation may be necessary, depending on student knowledge Text or other symbolic representations may be sufficient when students have considerable background. When students are less knowledgeable, higher fidelity simulation of the practical situation may be needed. There are several important characteristics to include.

- Learning is best situated in a social context similar to that in which the skills and knowledge will be used.
- The learner and the instructor are interactive participants in the learning situation: instructors model performance and cognition, then observe and coach student performance.
- Normally covert cognitive processes are displayed.
- Learners evaluate their own and others' performance (and vice versa) to promote tolerance for criticism, critical skills, and different perspectives.
- Systematic experiences are arranged in a range of conditions.
- Materials must take into account learner's frame of reference.

Example: Evidence from a recent study (Lajoie & Lesgold, 1991) shows that a computer-run version of a situated practice environment works. Students with 20–25 hr of practice in a computer coached practice environment equalled the performance of technicians with four years of on-the-job experience.

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Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, **18**, 32–42.

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12. Student Control of Learning

Finding: **Students' perception of who controls the key events in learning significantly affects their academic achievement.**

Comments: In the classroom, students generally attribute their learning success to a combination of ability, effort, task difficulty, and luck. They believe that if they can significantly control their learning, they can also organize their environment for maximum success; that is they can "make their own luck."

Research has repeatedly demonstrated that learning disabled and other slow students tend to think that other individuals cause their successes and failures. Successful students are more likely to recognize their responsibility for their achievement. According to recent evidence, student perceptions about who caused their successes and failures depend on situational factors. Certainly instructors can change these perceptions. Feedback pointing out the quality of performance and how to improve it can teach slower students to recognize that they are responsible for their learning and performance.

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Bar-Tal, D. (1978). Attributional analysis of achievement-related behavior. *Review of Educational Research*, **48**(2), 259–271.

Licht, B. G., Kistner, J. A., Ozkeragoz, T., Shapiro, S., & Clausen, L. (1985). Causal attributions of learning disabled children: Individual differences and their implications for persistence. *Journal of Educational Psychology*, **77**(2), 206–216.

Schunk, D. H. (1985). Self-efficacy and classroom learning. *Psychology in the Schools*, **22**, 208–223.

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13. Writing Text Materials

Finding: **Enhancement of text in books or manuals through orientation, summaries, examples and diagrams can aid student comprehension and learning.**

Comments: Much training is accomplished through written descriptions or discussion. Texts are prepared to serve as a basis for student learning by providing facts, examples, and explanations. To learn, students must understand the materials and how they can apply the information. Descriptions, instructions, and explanations are often difficult to understand because of terminology, inadequate connections to student knowledge, or a "topic-orientation" that tells all about a subject, but not "what a person does" or "how to do it."

Designers/writers need to be aware of student vocabulary and knowledge limitations. The designers should also use techniques that will help the students to comprehend and remember the course materials.

Writing should be performance-oriented, rather than topic-oriented. Topic-oriented writing looks like reference material aimed at a general, unspecified audience, telling all about a subject and not

how to apply the information. Performance-oriented writing focuses on specific users; describes their roles, tasks, and responsibilities; and gives them information they need about how to perform. The advantage of performance-oriented text is that readers do not have to infer and conceptualize what to do; it is stated explicitly.

The materials need to be explicit. Explicit instruction will result in the students demonstrating significantly greater metacognitive awareness of the content. Cues should be provided about what is going to be learned, guided practice of the to-be-learned material should be included and application examples are desirable.

Several techniques can be used to improve student comprehension of text:

- Pre-presentation summaries or "advance organizers" outline what is to be learned, provide structure, and improve learning.
- Inserting pictures showing spatial relationships, object form, or internal structure can be powerful aids to comprehension.
- Concrete examples can be used to clarify abstract ideas or depict how principles work.
- Methods that put demands on the trainee in reading and "processing" the text are especially useful.
- Questions inserted before or after text segments can help students to identify important information, and make desired inferences.
- Asking students to relate new information to what they already know or to paraphrase the content can aid learning.
- Writers can ask students to construct a diagram or "map" depicting the relationship of ideas in text to aid comprehension and remembering the information.

The insertion of interesting details in texts appears to divert attention from important generalizations in the text to the interesting and often irrelevant detail. Placement of the details, however, does not affect learner recall and appears to improve how interesting the text is — especially if the learners knew little about the topic being learned. It is probable that cartoons or other humorous insertions have similar effects. If the students lack interest in a course, or topic, the use of interesting materials should increase student attentiveness and attitudes toward the course.

Reading List:

Gagne, R. M. (1986). Instructional technology: The research field. *Journal of Instructional Development*, **8**(3), 7–14.

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14. Readability of Instructional Materials

Finding: **Readability scores indicate approximately how much difficulty students will have in reading or listening to training materials.**

Comments: Readability formulas predict how well people of varying reading ability can recall text they have read or heard. However, their usefulness for predicting comprehension of instruction is limited because they do not:

- Provide precise estimates of difficulty.
- Provide estimates of difficulty for non-text materials like tables and figures that make up much of the instruction in technical training courses.
- Take into account how the text materials will be used, for example, whether they are studied and learned or read while performing.
- Take into account students' background knowledge in the area and related areas. Students with a lot of background knowledge can attain high comprehension while having reading ability several grade levels lower.
- Provide specifications for writing readable materials; one *should not write to the formula*.

Issues other than readability should be considered in developing instruction. For example, performance-oriented text is recommended in manuals over topic-orientation. Topic-oriented text tells the reader

everything you want to know about the topic, but it does not tell what action(s) are to be performed. A reader must infer what to do. Performance-oriented text explicitly tells the reader what actions are expected of them. Surprisingly, technical manuals and texts are often topic-oriented.

Reading List:

Dole, J. A., Duffy, G. G., Roehler, L. R., & Pearson, P. D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research*, **61**(3), 239-264.

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15. Memorization Aids

Finding: **Mnemonic devices or coding systems help students recall important information when needed.**

Comments: Learning by rote seems an inefficient way of remembering. When people are faced with a rote memory task, they often try to devise

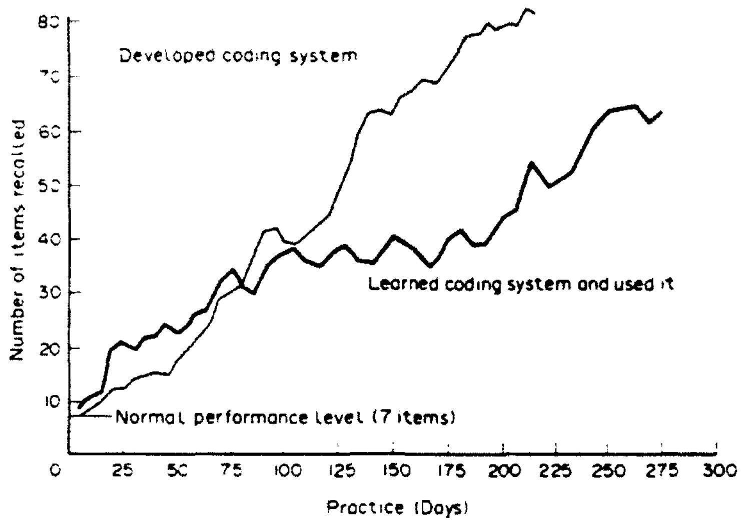
some scheme to make the learning task easier. Therefore, teaching students various types of memory devices or mnemonic procedures has often been proposed to make remembering materials easier. A pictorial mnemonic is also more effective than a figural, or schematic, taxonomy for lower recall and higher-order thinking skills.

Aids to memorization can take various forms which can be given to students. Some formal devices used in training which provide students with mental cuing structures are made up of visual images or words in sentences or rhymes that mediate between a signal to the learner to recall and the information to be recalled. Students learn the cuing structure first and associate each item of new information with one or more of the already memorized cuing structure. Later, they use the structure for recall through a self-cuing process.

Usually, the cuing structure is not conceptually related to the information it cues. For example, consider the rhyming peg-word mnemonic system "One is a bun; Two is a shoe; Three is a tree; etc...". Students first memorize the ordered rhymes. Then, when they must learn an arbitrary set of items in order, they relate the first with "bun," the second with "shoe", and so on. Instructions often suggest using visualization to help relate the items. Mnemonic devices are effective in helping students to recall unorganized names and procedural data.

Students can be encouraged to devise their own mnemonic devices such as a story to help recall a list of arbitrary words or phrases. Ship handlers have to remember colors of signal lights associated with marking intervals in distances between ships: for example, red (20 yards), yellow (40 yards), blue (60 yards), white (80 yards), green (100 yards). To remember the r y b w g sequence, students are asked to make up a sentence (or are given one). Thus, "rub your belly with grease" encodes the sequence, is memorable, and facilitates recall of the information. Mnemonic facilitation of memory results from the use of visuals which have meaning to a learner, can be retrieved as visual images, and thus facilitate recall.

Example: Normally, individuals can, in the short-term, recall a string of about seven unrelated items like digits or letters presented to them one at a time. However, recall performance can be improved to many times that level by using a learning strategy like coding items into more meaningful chunks, and by practicing a lot.



The figure shows data obtained from two persons who learned a way to increase memory-span to exceptional performance levels (Ericsson & Chase, 1982). The lighter line is that for a person who was read strings of digits and simply asked to recall them. He was a runner, knew much about running, running times and records for competition. Some digit groups reminded him of running times for different races, so he began to code 3- and 4-digit groups as running times for various races (e.g., 3 4 9 2 was coded as 3 minutes 49.2 seconds, near the world record time for a mile). As practice continued he constructed other mnemonic associations along with the times, such as ages and dates. With the development of this coding scheme he was able to recall about 80 digits accurately after about 220 practice sessions. Another runner was taught the memorization scheme. His performance on over 275 practice sessions is shown as the darker line. Both performed exceptionally. The important point is that coding schemes based on a person's existing knowledge can serve as learning strategies. Self-generated schemes are powerful tools in learning. Good ones can be useful to other learners, and provide them an early boost in performance. Furthermore, extensive practice is necessary to develop skill.

Reading List:

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16. Using Examples and Nonexamples

Finding: **Providing students with representative good examples and contrasting them with bad examples teaches them desired knowledge and skills.**

Comments: A problem when developing instruction is presenting of the subject matter to be learned in a form that promotes student learning. One technique for accomplishing this goal involves presenting contrasting examples that are accurate or positive representations and those that might be, but are nonexamples. Nonexamples refine the definitions or concepts being investigated by the learner. The contrast develops the learners' representation or knowledge.

It is necessary to collect a variety of examples that are not ambiguous or confusing which illustrate the task so the student will understand the problem being studied and not acquire misconceptions. Each example must be complete and self-contained. Each should contain the necessary critical features, or attributes, so the student can observe their presence or absence to construct adequate generalizations or representations of the task.

The form and fidelity of each example is important because it must adequately represent the critical features of the task. Examples should be as divergent as possible while belonging to the task being taught. This is done to prevent irrelevant features from being encoded into the generalization while facilitating the formation of

appropriate schema. Avoid extreme variations as they make examples difficult to understand or demand skills the student may not have. Easier examples should be provided early in the lesson with a gradual increase in difficulty.

It is important to use attention focusing devices to direct student attention to critical features, to the confusing features and to the absence of critical features. Learners tend to respond to similar sets of stimuli in similar ways even when the response may be incorrect in one situation. Discrimination is facilitated by exposing learners to examples paired with appropriate nonexamples which focus on the critical differences so they may be easily identified.

Just as students learn from their mistakes, they are not harmed by examples which do not reflect the instruction; instead these nonexamples refine and clarify definitions and illustrations.

Reading List:

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Gage, E. D. (1985). *The cognitive psychology of school learning*. Boston: Little, Brown and Co.

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Merrill, M. D. (1987). A lesson illustrating component display theory. In C. M. Reigeluth (Ed.), *Instructional design theories in action*. Hillsdale, NJ: Lawrence Erlbaum.

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FINDINGS ABOUT THE PRESENTATION OF INSTRUCTION

Following course requirements and content analysis, the design of instruction and the determination of presentation mode should occur. Presentation decisions involve instructor availability and skills, student study and listening skills, homework requirements and testing design.

17. Instructor Classroom Leadership

Finding: **Effective instructor leadership in the classroom promotes effective student learning.**

Comments: Instructors lead students to learning by focusing on performance, presenting well conceived learning objectives, conducting regular, and comprehensive evaluations of student learning, having high expectations of all students, and providing a purposeful and peaceful learning environment.

Instructors should protect minority opinions, keep disagreements under control, point out relationships between various opinions and ideas, and remind the class of the variety of potential solutions to a problem.

Instructors can observe each other in the classroom and comment on their observations. This constructive feedback can help the observed instructor become more effective and improve morale.

Good classroom management is essential for classes with problem students such as those who are consistent underachievers, hostile, aggressive, defiant, easily distracted, socially withdrawn, or rejected by the other students.

Instructors should give grades that reflect the student's skill or the degree to which they have achieved the course objectives as measured by a criterion test. Grades should not be used as disciplinary tools. When students actively participate in their learning, disciplinary problems are reduced.

Instructors must help students perceive the instruction as relevant and interesting, reinforce good behavior, seek friendly personal relationships with the students, help them develop a sense of right and wrong, and encourage them to cooperate with other students and staff.

Reading List: Brophy, J. E. (1985). Classroom management as instruction: Socializing self-guidance in students. *Theory into Practice*, **24**(4), 233–240.

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Zemke, R. S. (1981, June). 30 Things we know for sure about adult learning. *Training/HRD*, **18**(6), 45-52.

18. Instructor Classroom Role

Finding: **Student activities during learning are more important in determining what is learned than the instructor's presentation. Instructors aid student achievement by getting students to engage in activities that are likely to result in learning.**

Comments: Typical classroom instruction often places students in a passive role (such as listening or watching), where they learn less than when they are actively involved.

Effective instructors do not merely state facts and ideas; they know how to get students actively engaged in appropriate learning activities for attaining the desired outcomes. Learning is an active process in the learner; the instructor's task therefore involves more than dissemination of information. Instruction must consider factors such as prior knowledge, the context in which the material is presented, the uses intended for the outcomes, and the realization that student understanding of new information depends on how well it relates to their prior knowledge.

Students often begin learning with substantial misconceptions about the material they are studying and its intended use. Even students who get high grades have these misconceptions. Students also make systematic errors owing to misconceptions or erroneous procedures based on their current knowledge. The instructor needs to address the inadequate prior knowledge directly and present instruction likely to remove the misconceptions and faulty information. The instructor must understand how current and prior knowledge determines what the students will learn from new material that conflicts with

their existing beliefs. Students should be asked to reveal their misconceptions so that the instruction can confront them.

Instructors should set and communicate high expectations about what students can or cannot learn. Instructor expectations often become self-fulfilling prophecies as students tend to meet, but not exceed, instructor expectations. Too frequently instructors communicate low expectations of students by: (1) seating them in the back of the classroom, (2) seldom calling on them to answer oral questions, and (3) allowing them to do less work.

Instructors often function better as facilitators of student learning than in their traditional role as presenters of ready-made information. In a cognitively based view of comprehension-oriented instruction, the teacher is a mediator who assists learners to construct understanding about (1) the content of the lecture-text, (2) strategies for interpreting their instruction, and (3) the nature of the learning process (reading, listening) itself.

Reading List:

Brophy, J. E. (1981). Teacher praise: A functional analysis. *Review of Educational Research*, **51**, 5–32.

Dole, J. A., Duffy, G. G., Roehler, L. R., & Pearson, P. D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research*, **61**(2), 239–264.

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Snow, R. E., & Lowman, D. F. (1984). Toward a theory of cognitive aptitude for learning from instruction. *Journal of Educational Psychology*, **76**, 347–376.

19. Teaching Students How to Learn

Finding: **The ways students study influence what and how much they learn. Students can learn effective study strategies.**

Comments: Good students have been found to use study strategies which can be taught to others. Study or learning strategies may affect learner motivation or the way they select, acquire, organize, or integrate new knowledge. For example, learners may coach themselves to reduce anxiety, use imaging to relate vocabulary words and meanings, or summarize and take notes to memorize written material.

Average and low ability students use these strategies less than high ability students. Average ability students can learn the skills; however low ability students may need to be taught when, as well as how, to use these strategies. Once they have learned the strategies, all students can study and learn more efficiently, but they often need to be encouraged to do so.

Monitor and adjust the way they study based on:

- Whether they understand difficult material.
- How much time they have for studying.
- How much they know about the material.
- The standards they must meet.
- Space study sessions on a topic over available time and not to work continuously on a single topic.

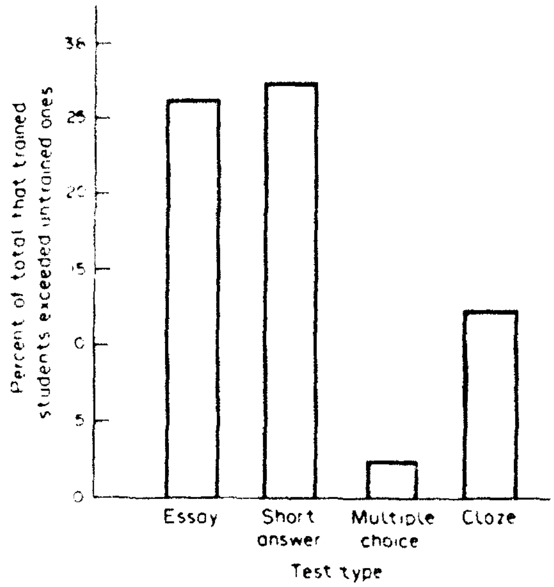
Use the study strategies appropriate for the learning task. For example, use rehearsal and self-testing to memorize ordered lists, take notes that paraphrase a lecture, or organize information in text by identifying the main ideas and relating them to prior or current knowledge.

Assess their progress by frequent self-questioning and modify the strategies as needed.

Example: *Training Students How to Learn from Text:* Training in techniques for learning from text materials has a substantial effect on performance on tests covering the content studied.

Students given training in how to study text material outperform students not given training. For example, they were taught how to make a network map of the information in the text, a spatial representation of the information and how to paraphrase, to draw pictorial representations of ideas and concepts in the network. Four different measures were used to examine the effect of the training. As can be seen in the figure, the trained students substantially outperformed untrained ones on essay and short-answer tests. The histogram bars show how much the scores of the trained students

exceeded those of untrained students. On a "cloze" test every *n*th word in the material is deleted, and the student tries to fill in the correct word from memory. Trained students showed superior performance on that type of test also. On a multiple-choice test trained students' superiority was slight. This type of test is not as useful a test for examining student learning and understanding.



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20. Instructor Presentation Stimulates Learning

Finding: **Students perform best when their instructors inspire them to take an active role in their learning.**

Comments: Good instructors are subject matter experts in what they teach, are well prepared for student questions, and stimulate student interaction. Because students can remember only a small amount of material presented orally or visually, emphasizing the systematic, logical structure of the material can help students learn and remember. It is also advisable to present no more than two or three main ideas in a 15 min segment.

Instructors can use techniques to stimulate students to assume an active role in understanding what is taught. For example, students learn best when they receive summaries of the main ideas or goals of the presentation. Reasons for learning the information, and illustrations, tables, and charts can be supplied for later study.

Instructors who ask questions and present problems force students to think of the appropriate answers and generate solutions. To encourage retention, instructors should review or summarize major teaching points to remind the students why they are important. To elicit more active learning in students, instructors can:

- Ask students to summarize.
- Involve students by providing obviously wrong information, which challenges them to think about and discuss their knowledge and beliefs.
- Divide students into small groups to get them involved in discussions.
- Ask questions randomly during lectures.

Student involvement increases when instructors relate directly *relevant* "war stories" or anecdotes and explain their relevance clearly.

When instructors tell students what they are expected to learn and demonstrate the steps needed to accomplish a task, students learn better. This "direct instruction" takes the students through the learning steps systematically, helping them to see both the purpose and the result of each activity. Direct instruction is particularly effective in teaching basic skills and in helping experienced higher

ability students master complex materials and develop individual study skills.

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21. Practice

Finding: **Opportunity to practice lesson-related tasks promotes learning new skills.**

Comments: Students learn more by doing than by watching or listening. They should have opportunities to practice the steps of any procedures they are learning. They should practice the new behaviors in a variety of situations that represent conditions in which what is being learned is used.

Instructors need to provide practice opportunities since practice improves performance. Separate each repetition of identical or similar drills with other drill activities.

Emphasize the key points during practice to increase the likelihood that students address and recall these key points. Explicit feedback

about performance helps students identify and correct performance difficulties.

The amount of practice required to perform a task correctly usually increases with the complexity of the task. In very complex tasks, however, components of the tasks need to be learned and practiced first and then combined later. For example, in air-traffic control training students spend much time practicing the entire task. Acceptable performance levels may not be attained by the end of the training program.

Sometimes, using the wrong learning strategy prevents learning with practice. In seemingly simple tasks such as memorizing strings of digits, students can practice for hours without improving their performance unless they are shown how to use grouping and coding schemes to help them learn.

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22. Peer Teaching

Finding: **Peer "teachers" and their students receive higher grades on tests and develop more positive attitudes toward the courses in which peer teaching has occurred.**

Comments: Peer interaction improves the academic performance and attitudes of the students who receive tutoring and those who provide it. Instructors can supplement regular classroom and laboratory teaching

with peer teaching. It helps slower and underachieving students to learn and succeed in school. The peer teachers benefit from preparing and giving lessons to other students because they learn more about the lessons they prepare and present.

Peer teaching can take a variety of forms such as:

- Teacher assistants leading discussion groups, seminars, or tutorial groups.
- Senior students assisting individual students (called the proctor model).
- Student learning groups that are instructor-less or self-directed.

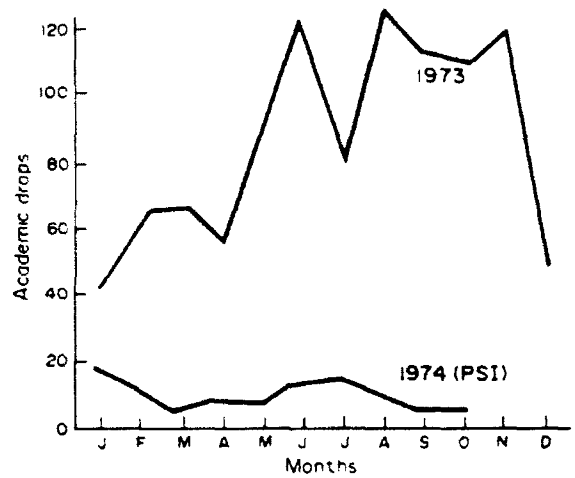
Student coaching usually raises achievement test scores. The effects are greatest in longer courses. Short test-taking oriented courses show the least improvement as a result of coaching methods.

Students bring a lot of invaluable life experiences into the classroom, which should be acknowledged and used. Students can learn much from dialogue with respected peers.

Example: Peer proctoring in a Navy technical school substantially reduced attrition in contrast to attrition in the standard course.

Senior students assisted individual students in learning using the Personalized System of Instruction (PSI) which is the proctor model. They made sure that learners did assignments, took tests, and restudied materials when necessary. The PSI was developed to assist in college teaching, but has been used in many adult training situations. PSI courses are mastery oriented, student proctored, self-paced, and use printed study guides to guide students' studying, and occasional lectures and discussion to stimulate and motivate the students. Reviews of numerous studies comparing PSI taught courses with those taught by standard classroom procedures find substantially better achievement for PSI students on various tests given during and after the course, even larger superiority on tests given weeks or months later, and better attitudes toward the course.

In a Navy technical training program in Propulsion Engineering, implementation of PSI resulted in a substantial reduction in attrition as shown in the figure below. The graph shows the number of students dropped from the course for several months in 1973 when it was fixed length and primarily lecture-based and several months in 1974 when PSI was implemented.



Typical behaviors of students involved with peer tutoring:

(1) Almost always more motivated; seem to have increased attention span and engage in more spontaneous conversation;

(2) More active and involved in their classes;

(3) Participation in learning increases and the nature of their discourse becomes more analytic and problem–solution oriented — which results in a large increase in vocabulary;

(4) Increased responsibility for learning (topics, pacing, and commitment).

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23. Listening Skills

Finding: **Students can be taught to improve their listening skills and this will increase their achievement.**

Comments: Students learn more from the act of listening than from any other perceptual act. While it is widely assumed that learners receive so much daily practice in listening that formal training is unnecessary, this assumption is incorrect for many adult learners; many major corporations, thus, have had to institute listening skills programs. Too many adults do not perceive much spoken stimuli around them, some fail to process it accurately and many more fail to remember what they have heard; too many listeners have bad listening habits.

An individual can be taught to listen! Many learners will achieve more after formal listening training. As a result, many colleges, industries and government groups have established classes to improve learning skills. Learning to listen is difficult. Retraining students to listen requires cognitive restructuring for learning new concepts and constant and appropriate application of good listening techniques. These students must acquire a positive attitude about learning to listen and generate determination toward this end to improve their listening habits.

There appear to be seven productive listening techniques which an instructor can teach to students:

- Generate interest in the speakers topic. Look at the speaker. Study the body language — does it support what the speaker says? Show the speaker your interest by your body language (reflective listening).
- Adapt to the speaker's appearance and delivery.

- Adjust to distractions. Your biases can restrict your perception. Abstain from faking attention and pretending to listen.
- Listen for the concepts and major ideas instead of facts.
- Listen to difficult expository material carefully. Then, interpret, evaluate and remember the most significant major points (or facts) by writing them down or memorizing them.
- Listen to the entire message before judging and refuting. Avoid interruptions or asking questions which disrupt the speakers presentation unless the speaker encourages interaction — or begins to ramble. Ask necessary questions after the idea has been presented.

These skills can be learned as a result of participating in exercises intended to refine these skills. After listening to a prerecorded tape focusing upon one or more techniques, checklists are often useful to help the learner focus on what they didn't perceive or their misconceptions. Instructors can function as facilitators of student learning, in addition to their traditional role as presenters of ready-made information, by teaching them to listen.

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24. Homework Assignments

Finding: **Student performance improves significantly when instructors regularly give out-of-class assignments, make sure they are completed, and give explicit feedback about the adequacy of the completed assignment.**

Comments: Students learn significantly more from their assignments when instructors write comments and grades on student papers. Furthermore, students in courses that require out-of-class assignments learn more than do students in courses without such assignments. The time students spend on relevant out-of-class assignments benefits them as much as in-class learning time.

Instructors can use out-of-class assignments to increase practice, which can be especially helpful for lower achievers. Low ability students who spend several hours on out-of-class assignments often obtain grades as high as students with greater ability who do no extra assignments. These assignments boost student achievement because they increase total study time, which influences how much a student learns. This can be helpful for all students, but may be especially important for those who are lower achievers.

Students are more willing to do assignments they consider useful. To benefit student learning, instructors can give the same care to preparing the out-of-class assignments as they give to classroom instruction, treat them as an integral part of instruction, evaluate them, and count them as part of the course requirements.

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Yeshurun, S. (1973). A reinforcement study on service courses in mathematics and statistics. *International Journal of Mathematics Education in Science and Technology*, **4**(2), 127–132.

25. Testing Student Learning

Finding: **Frequent, systematic testing and assessing of student progress informs students about their learning and instructors and managers about strengths and weaknesses in student learning and the instruction.**

Comments: Instructors test students and assess their work to learn what students already know and what they need to learn. They use various means, including observing laboratory exercise performance, giving oral quizzes and tests, assigning homework, asking questions in the classroom, and giving comprehensive performance tests.

Student errors on tests and in class alert instructors to learning problems that need to be corrected. Student motivation and achievement improve when instructors provide prompt feedback on their performance and assignments. "Teaching to the test" provides a good alignment between objectives, content and a test as long as the test examines the performance desired. The test should not focus on criterion-referenced items but upon primary application requirements found in-the-world.

In technical training, assessment should be as job-like as possible. This means emphasizing hands-on performance tests, limiting pencil-and-paper tests to safety and knowledge critical for job performance, and stressing open-book testing in which students use manuals and other references normally available on-the-job. Frequently tested students outperform less frequently tested ones in the classroom.

Students generally take either knowledge or performance tests. Knowledge tests help instructors find out if the students have learned information important for safety and knowledge important for performance.

Performance tests enable instructors to determine student competence, and identify student and instruction problems. The instructors biggest concern with testing is to identify what the students do not know. Performance difficulties often indicate gaps in student knowledge, and their explanations of their actions or answers to questions can confirm an instructor's inference.

Reading List: Bangert-Drowns, R. L. *et al.* (1986, April). Effects of frequent classroom testing. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

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26. Giving Feedback to Students

Finding: **Students who receive constructive feedback about the accuracy and adequacy of their performance become more interested in the class and learn more.**

Comments: Giving constructive feedback to students about the adequacy and accuracy of their actions is an effective way for instructors to aid student learning. Timely comments about their performance provide important recognition of their effort and help correct errors. Feedback for retrieval and application of specific knowledge stimulates the correction of erroneous responses where its reception is encouraged.

No one method is best for providing feedback to students, but instructors can follow some useful general rules. Whether or not an answer is correct, the feedback should be prompt and provide useful information. Even after a correct answer, feedback emphasizing the method used to get the correct answer reinforces the solution and, if

other students are onlookers, they can understand why the answer is correct.

Instructors should give nonspecific praise and criticism infrequently and, even then, base it on the quality of student performance. It is better to explain correct or incorrect performance than to give only the correct answer or to judge the student performance. Feedback should routinely tell students when they are incorrect, but should focus on the content and explain how to reach the correct answer. Critical feedback, written or spoken, should be given in private and not in front of the class.

By giving constructive, timely feedback, instructors can reinforce and help students develop positive self-esteem as well as improve their performance. Students who believe they can succeed are usually more successful than those who are less sure of their ability. Usually, students who believe they can succeed are more active learners, work independently, cooperate with other students, and achieve more.

Recent research suggests that feedbback can be overdone. A committee of The National Research Council reported that too much feedback from instructors may be bad for long-term performance. While feedback is an essential part of learning, it occurs naturally when a learner practices. Augmented feedback from instructors — such as telling a trainee what he or she is doing wrong on each attempt — can be excessive. Reducing augmented feedback to perhaps once in every five trials may even improve performance.

Feedback within programmed materials also seems to positively affect learning. Mediated intentional feedback for retrieval and application of specific knowledge appears to stimulate the correction of erroneous responses in situations where its mindful reception is encouraged.

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FINDINGS ABOUT THE EXPLOITATION OF INSTRUCTIONAL TECHNOLOGY

Decisions concerning the use of instructional technology need to be made as a part of the curriculum design process. A decision to use an instructor, computer, distance learning program, and/or other media represents major cost, instructional design and time-to-implementation commitments. Individual student-oriented simulations, gaming, and virtual reality decisions permit the integration of many skills in a manner that is impossible with more traditional group-oriented media. Distributed instruction may permit a significant reduction in training costs compared to alternative media. Instructional technology can be exploited in many ways to improve the learning process.

27. Cost Effectiveness

Finding: **Consistent and credible evaluations of cost-effectiveness must justify any plans to substitute alternative instructional programs for those now in use.**

Comments: Because of the rapid decline in the cost of computer-based and communications technologies during the last decade, they are attractive alternatives to the conventional lecture method of providing instruction for many types of programs. Interactive videodisk instruction, for example, has been found to significantly increase learning and decrease learning time in both industrial training and in higher education. The interactive video training was also less expensive than traditional instructional methods. These cost savings are found only if the teacher–pupil ratio is increased. If the traditional components and processes (T/P ratio, grading procedures, classroom sizes, fixed length of class periods) are unchanged when these media-based systems are introduced, the new technology merely increases the already high cost of instruction. To offset or justify the cost of the technology, benefits should be demonstrable. For example, instructor productivity or the number of students graduated in a time period should increase, student performance should improve substantially, or administrative burdens over the life of the system should be reduced. Such changes require good management planning as well as changes to the instructional program.

The decision to implement a particular instructional program, course or device or to change an existing one rests upon identifying all the costs of all the alternatives such as the cost of research and development, all personnel costs in development, the development as well as delivery costs of all versions of the equipment, the cost of running the implementation for the life of the system including operation and maintenance. Then, if the instructional systems demonstrate about the same effectiveness, the one that costs less might be preferred. Substantial, demonstrated differences in instructional effectiveness might justify choosing a more costly system. Both cost and effectiveness must be considered explicitly in analysis conducted to enable selection among alternative instructional programs, courses, or devices to fulfil a specific need.

Cost-effectiveness of instruction can be improved by the use of instructional technology even if it often entails additional personnel costs to select/evaluate, design, and revise, these materials. The important related questions involve a discussion of whether or not to use computers, to the more relevant question: how to assign and implement the appropriate interactive technology in specific classes.

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28. Programming Instructional Presentation

Finding: **Instructional materials can be organized systematically, can be presented by various media, and are more effective than conventional classroom instruction.**

Comments: Structuring instructional materials by dividing them into learnable segments, determining their presentation order, and requiring students to pass tests to demonstrate their comprehension before allowing them to go to new material works about as well as conventional methods. Structured instructional materials, or *programmed instruction*, also provides students with an opportunity for

self-paced study, which can save considerable training time, and can be distributed to remote locations as alternatives to lectures.

Sequences of instruction are designed to require an active response from students before new information is presented. Students get immediate feedback telling them whether the response was correct. Sometimes branching enables students to omit material they already know. If students make errors they may be required to study segments again. This method of organizing and presenting information can be used to deliver instruction on various media such as computers, workbooks, or lectures. Many computer-aided instruction (CAI) programs are examples of structured instruction; others use simulation or gaming techniques.

Students who progress through the materials at their own rate complete the materials in about one-third less time than do students who attend conventional courses.

While some students will learn a particular task regardless of the delivery medium, others take advantage of a medium's specific characteristics to help construct knowledge. For example, the serial processing of linguistic and pictorial information in books is influenced by the medium. The information provided by television is influenced by the simultaneous presentation of its symbol systems and the information coded in it. Computers influence learning with their ability to dynamically represent formal constructs and institute procedural relationships under the learner's control.

Reading List:

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29. Programmed Instruction Workbooks

Finding: **Programmed training materials reduce training time about a third compared with standard instruction without affecting student achievement.**

Comments: Aristotle said, "We learn when what we do has reinforcing consequences." Reinforcement is basic to programmed instruction (PI). PI presents information in a structured manner congruent with current learning theories. PI emphasizes graded difficulty, corrective feedback and self pacing. The PI procedure is often equated with the general concept of "instructional design."

The basic steps in developed PI materials are: (1) Perform a task and learner analysis: (2) develop behavioral objectives; (3) write and edit materials in accord with current learning theories: and (4) Perform empirical testing and revision until the objective "conditions" and "standards" are met — or until the materials are rejected.

Programmed instruction usually results in equivalent learning in from one-half to two-thirds the time required to lecture the equivalent material, or, as learning time is increased, the standards tend to be exceeded.

PI tends to be cost-effective, even given the large front-end development effort, because instructors can monitor more students so instructor costs may be reduced. Where students are either at multiple sites or where they may be available to start instruction over a period time. PI permits additional time savings by permitting them to start instruction "on demand" because of its self-pacing character.

The use of individualized "programmed materials" allows an instructor to help specific learners with their unique problems — thus potentially increasing the quality of instruction.

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30. Computer-Based Instruction

Finding: **Computer-based instruction teaches students the same content as well as or better than a regular classroom situation, usually in less time.**

Comments: A review of nearly 200 studies comparing computer-based instruction (CBI) with conventional elementary, secondary, and college classroom instruction found that computer-based instruction raised student achievement significantly, gave students a better appreciation of technology, improved student attitudes toward schools and teaching and helped teachers manage instructional time. A review of 40 studies comparing military classroom instruction with computer-based instruction found that CBI student performance achievement improved in 15 cases, remained the same in 24 cases and became worse in 1. In addition, students completed the CBI lessons in about 30% less time than that allotted for the conventional courses. This finding may be important where students are paid and training time needs to be as brief as possible. This evidence tends to verify the suitability of computer-based training in the military.

Th. se effectiveness and efficiency gains did not result simply from using computers in instruction but from imposing a systems approach for design on the courses and allowing students to progress at their own learning rates. In military courses where course materials and tests already address training objectives derived from job-task analysis, gains in student performance would not be expected, although time savings compared with the length of conventional courses would be expected. Therefore, careful planning is necessary before deciding to use computer-based instruction in each situation and, only if cost-effectiveness evaluation justifies its use, should it be adopted.

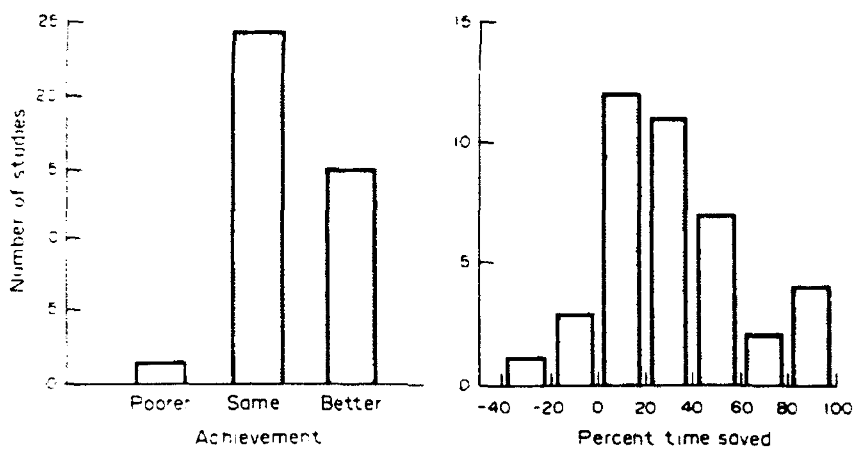
Sequences of instruction are designed to require an active response from students before new information is presented. Students get immediate feedback telling them whether the response was correct. Sometimes branching enables students to omit material they already know. If students make errors they may be required to study segments again. This method of organizing and presenting information can be used to deliver instruction on various media such as computers, workbooks, or lectures. Many computer-aided instruction (CAI) programs are examples of structured instruction; others use simulation or gaming techniques. Computers have the capability of creating dynamic, symbolic representations of nonconcrete, formal constructs which are frequently missing in the mental models of novice learners. Learners can manipulate these representations on computers to work out differences between their incomplete, inaccurate mental models and the formal principles presented via the computer.

Students who progress through the materials at their own rate complete the materials in about one-third less time than do students who attend conventional courses. Better yet, studies of students using computers for instruction, show that students learn at least as well, or better, when paired at a computer as they do by working by themselves on a computer. Students who use CAI for drill and practice in pairs perform better than students who use the same program individually. Learner attitudes toward their class-mates also improves when they are paired. Cooperative learning promotes positive feelings of personal worth and positive attitudes toward the course content; low ability students who study mathematics in pairs usually have reduced anxiety toward mathematics. The pairing of learners makes CAI relatively cost effective.

Learners prefer having an instructor present the instruction, partly because they have learned to learn in a lecture situation. They prefer sitting in a classroom with a human being who can listen and respond rather than sitting in a media carrel with a computer terminal or a slide–tape program. Student attitudes toward the content, however, do not vary much in either situation.

On-line CBI is as effective as classroom-based lectures when computer communication (electronic conferencing/electronic mail) between faculty and students is possible. The Virtual Classroom project involving several courses at the New Jersey Institute of Technology and Upsala College found that students were more actively involved in the computer classes and attitudes were increased with no measurable differences in learning.

Example: In military training courses, computer-based instruction has been found to be at least as effective as standard lecture courses and students complete them substantially faster. The following figure, taken from Orlansky and String (1979), provides a graphic summary of a review of 40 research studies comparing the effectiveness of computer-based and standard training in the Navy, Army, and Air Force. Fifteen studies reported higher achievement for students in the computer-based courses, and 36 reported that students in computer-based courses finished in less time.



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31. Hypertext-Based Instruction

Finding: **The use of random access computer technologies, like hypertext, makes practicable new forms of nonlinear and multidimensional learning and instruction better suited to conveying complex content.**

Comments: Traditional methods of instruction as lectures, textbooks, and video tapes rely on linear presentation strategies. For subject matter which is well structured and relatively low in objective taxonomies these linear methods are adequate. For complex content which is ill-structured the unidimensionality of linear structures is not efficient. Instructional techniques which allow a degree of random access to a variety of media can be very efficient.

The need for hypertext-based instruction has been demonstrated in such diverse areas as literary comprehension and interpretation, biomedical cognition, history, and military strategy. In literary study the mere chronicling of events is not sufficient; a literary work usually contains many themes and symbolic structures which lend themselves to study in diverse ways, be relevant at irregular intervals and allow the study of intricate patterns of various themes. Transfer-related objectives are often made possible by this technology. This random-access form of instruction may alert students to the hazards of oversimplification and to prepare them to deal with complexity across content domains.

The role of the student-user is one of active participant and explorer within the "data-base" as opposed to relatively inactive listener.

Instructional design of hypertext-based materials varies from traditional instructional development activity. Many hypertexts are based on small, relatively uncomplicated case-studies which can be thoroughly explored by the user. By overlaying more points of view on the same content materials permits an incremental buildup of a picture of interrelations among the thematic perspectives. Many instructional units will not have a "solution" but will retain an openness of data interpretation — right and wrong is often hard to determine in the real world. Two of the major problems of hypertext instructional systems involve the labyrinth of content connections and the need to prestore their links.

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32. Visual Representations for Learners: Television/Interactive Video/Videoteletraining (VTT)

Finding: **A lecture delivered using instructional television is about as effective as a live instructor. Television works better than an instructor-based system when realistic visuals are required to master the content.**

Comments: Interactive video instruction (IV) is an effective form of instruction. The effects of using interactive video instruction is similar to that of computer-assisted instruction.

Visual attention is positively influenced by "formal features" such as different types of voices, laughing, sound effects, music, and visual movement (high physical activity, animation, cuts, zooms, pans). The combined use of visual and auditory symbols result in more viewer/learner recall than visual-only or audio-only presentations; when presented together each source provides additional, complementary information. In video presentations, the linguistic information should be presented simultaneously with, or just following, the visual information. Video viewers seem to use their prior domain knowledge to process information at the presentation speed and supplement information they miss or do not understand; if the topic is unfamiliar they will have little supplementing information in long-term memory and the pace of the presentation may easily exceed their capacity to process the presentation (and learning

will fail to occur). Pacing should reflect the skill level of the video presentations intended audience.

There are differences in student achievement between conventional grouped instruction and IV. The effects of learning from interactive videodisk-based training systems is also a little different than that resulting from noninteractive videotape-based systems. It appears that when comparing IV instruction with noninteractive instruction, or conventional instruction, that achievement may improve by as much as 15 percentage points, based on 24 military studies, while 14 studies in higher education raised the achievement by 25 points. Many of the studies favoring group instruction seem to be explained by factors such as decisions made by the teacher relative to the amount of practice, the extent and kind of feedback, and the nature of remediation procedures.

External, program controlled interactive video instruction appears to be more effective than learner-controlled IV. IV is best accomplished when it is structured and provides guidance as opposed to being primarily under the control (pacing, sequence of instruction) of the students.

Live video presentations, video taped lessons, video distance learning and interactive video courses often provide time and cost effective alternatives to traditional instructional procedures. Video presentations, like all other presentations, are delivery systems for communicating course content and are not ends in themselves.

Both live television courses and video taped lessons provide effective alternatives to conventional instruction for most learners and most course content. In many cases where the instruction is provided by video distance learning techniques, the method is very cost effective; it eliminates most travel and per diem costs (a major cost consideration) while increasing instructional hardware and communication costs (moderate cost items). In addition, this form of communication allows course managers, instructional developers or other instructors to easily monitor the quality and uniformity of lessons before (if they are recorded) and during the broadcast presentation.

Interactive video courses have shown they will often increase student learning and/or decrease learning time and/or decrease training costs as compared to traditional training methods. Interactive videodisk instruction is more effective the more the interactive features of the medium are used. The method is equally effective for knowledge and performance outcomes.

Videoteletraining (VTT) systems are extensively used in higher education, industrial training and in the military. VTT provides a low cost alternative for providing remote instruction. VTT may involve the use of videotapes, interactive videodisks or audiographics. The biggest problem in using VTT involves obtaining adequate audio feedback from the students to the instructor. VTT, like most other instructional television-based instructional systems works at least as well as conventional training methods for most courses.

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33. Simulations and Simulation Games

Finding: **Simulations and simulation games provide effective instruction in complex skills as substitutes for instruction on equipment in the actual performance environment.**

Comments: Instructional simulations abstract portions of a real environment in order to provide instruction that otherwise would require an actual, "hands-on" performance situation. The real situation may be dangerous (e.g., practicing how to react to nuclear powerplant malfunctions), distant (e.g., transporting the learners to the moon to experience the effects of its gravity), expensive (e.g., using a flight simulator to practice aircraft landings without the expense of operating an aircraft), or politically sensitive (e.g., learning the communications and other problems involved when a local community, and government agencies confront industrial pollution). Computer-based devices are often used to provide the simulation. They range in realism, from high fidelity (e.g., regarding the visual and motion systems of the actual tasks) to (lower fidelity) abstract symbolic representations of actual tasks or partial tasks. A simulation game can also vary in realism, but adds an additional set of rules to introduce competition and determines a winner or winners.

Simulation devices provide learners with situated learning that exercises the cognitive and physical activities of the real task. Whether the physical actions need to exactly duplicate those of the real task is an important issue for design because that requires high physical fidelity at considerable cost. Research has shown that lower fidelity devices can provide learning that translates into good job–task performance. Recent research emphasizes a psychological, conceptual fidelity as the primary dimension to consider rather than physical fidelity.

As an example, simulations provide students with self-contained "micro-worlds", such as representing on a computer screen a frictionless world where the laws of Newtonian physics are more apparent; one in which the learner can experiment and quickly see results. Learners can test abstract concepts and experiment with scientific processes that are not feasible or are too dangerous for actual classroom work (such as the operation of a ship's propulsion system). Simulations are also effective tools for training police how to manage social or other sensitive problems. By playing the role of world leaders or citizens in other countries, for example, trainees can engage in high level critical thinking, gain a better understanding of political affairs, and appreciate different perspectives on sensitive issues.

Instructional simulations and games provide situated, authentic forms of practice, feedback about errors, depict how a device or system works, and can motivate learning while avoiding physical danger and temporal constraints. In addition, simulations can use strategies effective for supporting student learning about the task. For

example, rather than simply replicating the timing of real events, in a simulation timing can be slowed for the new learner, and speeded-up later. Explanations can be given at decision points to support learning, and to correct errors. Normally invisible events or processes can be made visible to promote understanding, such as showing the flow of electrons in devices. Therefore, at times, simulations may be preferable to instruction in the actual performance situation.

Simulations intended to instruct novices may need to be designed quite differently than those intended to provide practice or retraining for moderately competent students. Novices need extensive guidance and precise corrective feedback to reduce their errors, while trained students may hone their skills and broaden their knowledge of new and unusual situations/cues/events that may be encountered in the "real world." New learners need simplified examples of problems to facilitate their learning. The effectiveness of a simulation results from the instructional methods incorporated into the device that support student learning rather than from any simple physical or functional similarity to an actual device. Thus, the design decisions are based, for example, on ways to isolate, or discriminate cues, and ways to provide time-compressed practice for skill development.

An instructional simulation game is like a simulation but has an additional set of rules (often mathematical) to identify a winner or winners. These games which have individuals compete against each other are motivating for many learners and are good at teaching objectives involving procedures and decision-making or psycho-motor development. Adventure games, as opposed to more instructionally oriented games, seem to have limited application in the classroom beyond overcoming a users fear of computers and helping them to understand how to operate the machine.

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34. Distributed or Distance Instruction

Finding: **Students not at formal schools can interact with instructors through modern communications technology such as networked computers or through an instructional television network.**

Comments: Through instructional electronics networks, apprentices, alone or in small groups, can learn skills and knowledge where they will use them. A telephone computer network controls audio or electronic exchanges between students and instructors, while satellite, cable, or cassettes deliver video if needed. Participants can work on problems peculiar to their own situation when their scheduled work allows. Variations are possible; for example, participants can delay the interactions by storing questions, answers, and comments until they have time to address them.

Microcomputers can also serve as terminals to remote data banks and network members. Through telephone connections and a centralized message workspace, learners can ask questions or propose solutions to other members sharing the network.

Several sound educational benefits result from distributed instruction:

- Enables beginning apprentices to observe interchanges between more experienced apprentices and instructors and to develop their skill in approaching problems gradually.
- Reaches learners where and when the training is needed.
- Shifts more responsibility for acquiring the skill from the trainer to the learner.
- Individualizes studying and increases student interaction with materials.
- Uses the learner's and trainer's time more productively.
- Saves travel time, cost, and time away from the job.

Reading List:

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35. Job Performance Aids

Finding: **Job performance aids are effective training devices for skill development.**

Comments: Job aids differ from training aids in that training aids are documents or devices designed to encourage learning of particular skills or knowledge, whereas job aids are designed to assist in the performance of work activities in the work environment. But, job aids can help learners become proficient at a task, fulfilling an instructional role.

Job aids serve in many roles including maintenance and/or troubleshooting tasks, cueing, analogs, and examples. Job aids that serve as procedural models typically provide step-by-step directions for accomplishing an objective, whereas those whose purpose is to provide performance cues are designed to provide signals to act in a specific way without complete step-by-step directions. Job aids serving an associative role are often designed to enable the user to look up data relating to an existing piece of information.

The effectiveness of job aids have been demonstrated in many situations and tasks conditions. In one case a job aid was developed for a sophisticated radar system and was to be used by low-aptitude novice maintenance technicians. A comparison was made to determine the time saved by technicians who used the job aid versus those who used the conventional manuals which already existed for the system. The novice technicians using the job aids were capable of reducing the time required to isolate and correct a malfunction by as much as 50% over the time required by highly trained technicians using conventional procedures.

To design a job aid the following procedure should be considered: (1) Identify the tasks elements for which job aids should be considered, (2) determine the job aid functional characteristics which will enhance the performance of each task element, (3) specify the physical design characteristics required of the aids to carry out the necessary functions, and (4) evaluate, modify, and update the resulting aids. The evaluation step is a critical element in the design process as it provides feedback to the designer as to the effectiveness of the job aid. A set of criteria that can be used for evaluating job aids which

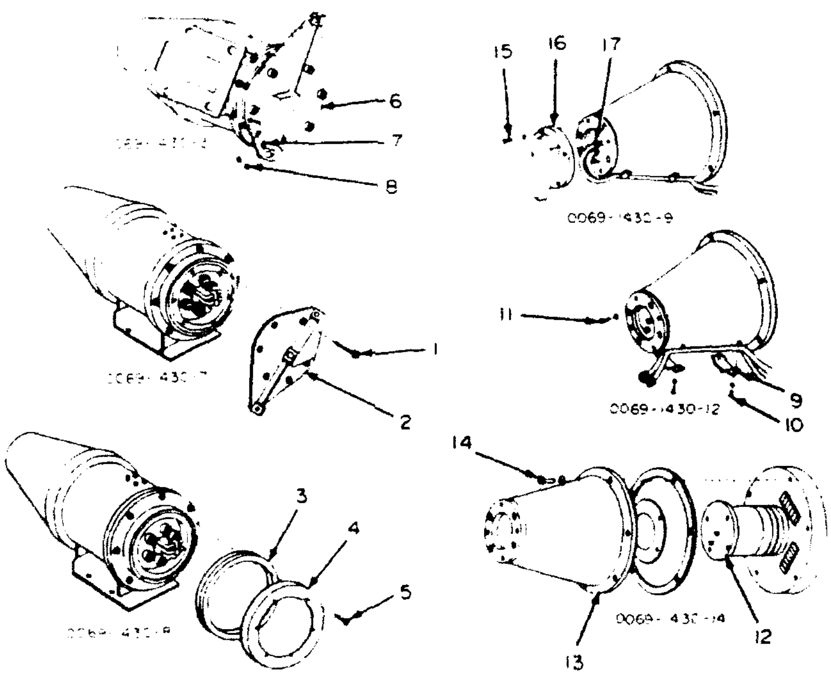
are essentially applicable to any information presentation strategy are: Comprehensiveness, degree of prescription, reliability/validity, user opinion, and cost.

Example: The Air Force has developed the "fully proceduralized" job performance aids or JPAs. A salient feature of fully proceduralized JPAs is that they are entirely job-oriented and provide illustrated step-by-step instructions for the performance of linear tasks, that is, tasks whose sequence of steps never vary, such as cleaning, lubrication, inspection, removal, and installation, as well as branching diagnostic routines (such as check-out and troubleshooting activities).

Repair elevation drive assembly

Disassemble elevation drive assembly

1 Remove two coaxial connector nuts (8)
2 Remove six screws (1)
3 Depress two coaxial connectors (7) into end plate (6)
4 Remove end plate (2)
5 Remove six flathead screws (5)
6 Remove closure seal (4)
7 Remove V-seal (3)
8 Remove four screw (15) Remove guard (16)
9 Disconnect two coaxial connectors (17)
10 Remove four screws (10) and two clamps (9)
11 Remove four screws (11)
12 Remove six screws (14) and six washers Remove rotary joint support (13) and hold rotary joint (12) with one hand



A task analytic process must be complete prior to JPA development so that the JPA can be precisely specified. This involves a large matrix in which every possible task performed on each piece of equipment is identified. Furthermore, the training as well as the experience level of a document's user is carefully defined, and each task identified in the matrix is assigned for coverage either via a JPA or via training. Every hardware component whose failure must be identified is listed. In addition to troubleshooting logic, the final product includes step-by-step procedures for access and adjustment tasks. All procedures are necessarily accompanied by illustrations. The figure on page 408 shows an example of a JPA frame.

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Swezey, R. W. (1987). Design of job aids and procedure writing. In G. Salvendy (Ed.), *Human factors handbook*. New York: Wiley & Sons.

36. Adopting Training Innovations

Finding: **Managers and training developers can effect the rate at which the schools and instructors adopt and use newly developed training materials and programs.**

Comments: From the time an instructional development project is first conceived, developers and schools should consider the strategies to use to encourage the potential users to adopt the new materials. Too often, materials are adopted only where they were developed — that is, the "not developed here" syndrome. One way of overcoming this attitude is to involve all potential users in the analysis and design phases of innovative courses.

Using an effective person as an agent to manage change is a critical factor in diffusion. The agent studies the potential adopting organization and systematically shows that (1) the innovation has obvious advantages over the existing process, materials, or equipment, (2) it is compatible with the existing system, (3) significant research and/or evaluations reveal the innovation's advantage, (4) there is a rational sequence for its adoption and application, (5) it addresses an identified need of the potential user, (6) the innovation will be used for a long time, and (7) the staff can acquire the skills needed to adopt the innovation.

The manager must concentrate on the potential users and their needs rather than on the material or the innovation, must know as much about the situation as the potential user, be ready to tailor the innovation to the user's needs, and explain the innovation to the potential users.

For any instructional technology, as for computer-based technology, to have an impact on the learning process, teachers must be comfortable with computers, seeing them as tools that enhance rather than interfere with their daily teaching. For this to happen, instructors need special training. Unfortunately, the vast majority of today's teachers have had little or no training on how to apply computers or other individualized teaching technologies in their instruction. Recent reports, summarized by the Office of Technology Assessment, suggest that only about one-third of all instructors have had even 10 hours of computer training.

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37. Designing Effective Illustrations and Graphs

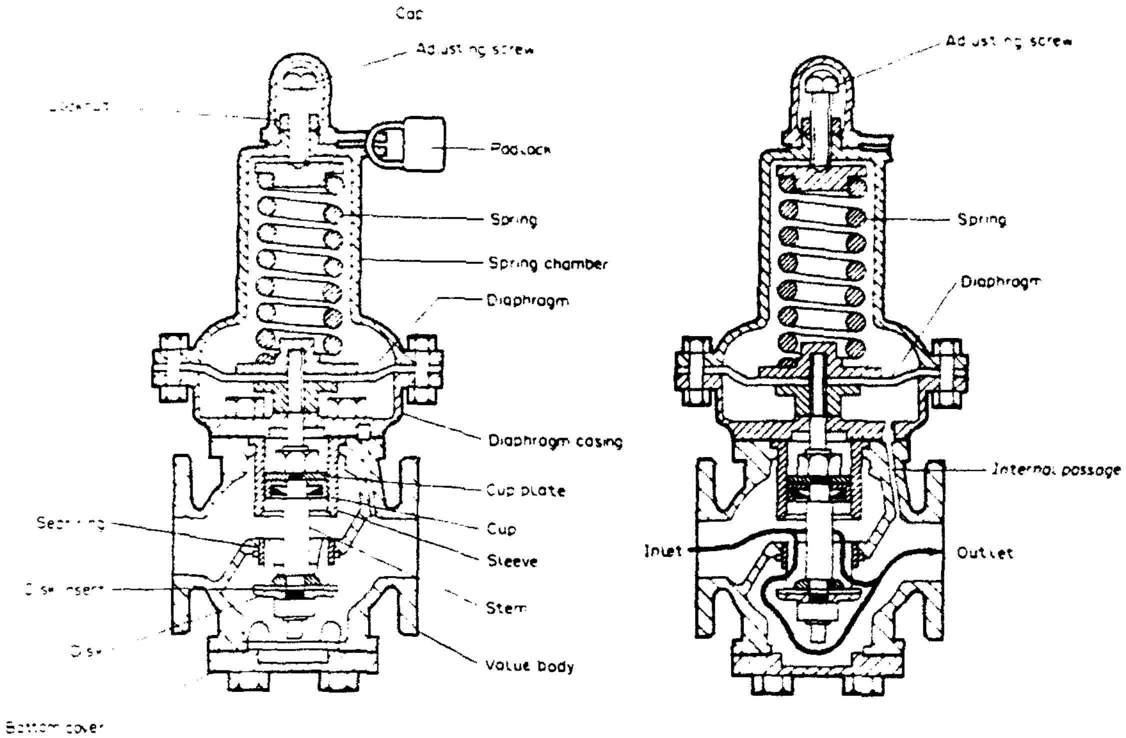
Proposition: **Diagrams, graphs, photos, and illustrations can improve student learning.**

Comments: Illustrations enhance text instruction by helping the students perceive and remember the instruction. Illustrations should be as simple as possible to reduce potential confusion with irrelevant details. For that reason, line drawings are often more effective than complex drawings or photographs. Color illustrations are needed only when color itself is important to cue what is being learned.

Pictures or other illustrations not directly related to the presentation are unnecessary. Such materials are often more distracting than helpful. Highlighted or labeled information can aid learning, but be careful to avoid confusing clutter. Several illustrations to show the various switches or components relevant to the current instruction are more comprehensible than one cluttered one.

The use of color may encourage students to examine the materials. In these cases, the advantages outweigh the potential confusion. Animation, use of many visuals changing at a rapid pace may increase student attention to a presentation; this technique may be used for training where the students may have little interest in the course or content.

Example: *Effective Illustration:* Two illustrations are contrasted in the following figure. The valve on the left is from a Navy rate training manual. As a depiction for explaining how such valves operate, it is confusing and cluttered. It needs to be simpler and show only those parts most intimately involved in the process of reducing pressure from one level to another. Irrelevant labeling and construction detail were removed on the valve at the right to show the parts most important for explaining how the valve works.



Once it is decided that an illustration is required to support learning, a simple illustration depicting just the relevant detail is preferable (Fleming, 1987). The design of a display is determined by attention to the perceptual limitations of students, limits on their ability to process information, and knowing about what students know and understand. Since these characteristics are primarily qualitative, tryouts with typical students are useful for validating design decisions and revising illustrations.

Reading List:

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FINDINGS ABOUT THE EVALUATION OF INSTRUCTION

Following the analysis of the training requirements, the design of the instruction, and the production of the training program, it is desirable to determine if the training program works and what the students have learned. The use of formative evaluation will permit the instructional developers to improve the quality of the current, and future materials. Summative evaluation will ensure that there is a good correlation between the intended training outcomes and the real ones. The assessment will also permit the identification of instructors who need additional training.

38. Criterion Referenced Testing

Finding: **Testing needs to be geared closely to the goals of a training program.**

Comments: Testing during and after instruction is used to indicate student progress, determine what students find difficult, and tailor individual assignments to overcome the difficulties. The testing therefore, is focused on performance requirements which are derived from analysis of the work trained individuals are expected to do. Various means of testing are used including laboratory exercise performance, oral and written quizzes and tests, out-of-class assignments, classroom questions, and comprehensive performance tests.

Assessment needs to be as job-like as possible. This performance-based assessment should make the elements of the test as much like the elements of the criterion-based objectives as efficiency will permit. Performance tests should be hands-on and pencil-and-paper tests of knowledge should be restricted to safety and knowledge critical for job performance. If workers use manuals and books to find the information needed to carry out a task on-the-job, open-book testing should be used.

Well designed, performance-oriented tests inform students about job requirements and guide their learning. Frequently tested students outperform less frequently tested ones. Students generally take two kinds of tests: knowledge tests and performance tests. Knowledge tests help instructors find out if the students have learned information important for safety, and knowledge important for performance. Performance tests indicate student competence and provide information about both student and instruction inadequacies. Errors that students make on tests and in class identify learning problems that need to be corrected. Instructors need this information to provide prompt feedback to students on their performance and assignments and to help correct any difficulties they may have.

Reading List:

Baker, E. L., & O'Neil Jr. H. F. (1987). Assessing instructional outcomes. In R. M. Gagne (Ed.), *Instructional technology: Foundations*. Hillsdale, NJ: Lawrence Erlbaum Associates.

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39. Course Evaluation and Revision

Finding: **Tryouts during development of instructional materials help to diagnose and repair inadequacies in the instruction.**

Comments: Designing instruction involves making many decisions such as how to present information to the students, judging student comprehension, and knowing when they have learned enough to move on to new material. The design and development process involves numerous subjective decisions, and quality of the instruction depends on the skill and knowledge of the developers. The material may only approximate the optimal product. Evaluating and revising the instruction to improve it is an important part of the process.

The instructional developer accomplishes this by trying out segments of material on a sample of the target students. Ideally, a developer goes through the material with one student at a time. During tryouts,

students might be asked about the quantity and quality of examples in the instruction, the adequacy of opportunities provided for practice, the suitability of media selected for a given training domain, the compatibility of the reading grade level of the materials and the student audience, and the time required for the student to complete the instruction compared to allotted training time. The developer then revises the materials to address problems uncovered in tryout and conducts another tryout with different students.

Training development rarely includes this evaluation–revision cycle. Tryouts of materials in nearly final form are more common. At this late stage, however, it is difficult to diagnose instructional problems unless gross failure makes them apparent. The lack of evaluation during development degrades quality and makes revision of instruction a major undertaking.

Managers who plan and allocate adequate resources for early evaluation make revision and the instruction more effective.

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Montague, W. E., Ellis, J. A., & Wulfeck II, W. H. (1983). Instructional quality inventory: A formative evaluation tool for instructional development. *Performance and Instruction Journal*, **22**(5), 11–14.

40. Evaluating and Supervising Instructors

Finding: **Instructors can improve their performance if they are given relevant useful information.**

Comments: When training organizations have students rate their instructors, instructors can use the ratings to improve their teaching. Evaluation studies show that feedback from the ratings does improve instructor performance.

Instructors who receive mid-course rating feedback obtain substantially higher end-of-course ratings than do instructors who are rated only at the end of the semester. Ratings improve even more when instructors discussed the mid-course ratings with consultants or received other help in interpreting and reacting to the ratings.

Focusing the mid-course evaluations on the entire course including the content, facilities, instructor, and the instructional materials, seems to result in more positive corrections than the more traditional end-of-course instructor evaluations.

Effective managers ensure that the instructors know the subject matter and can communicate it. The teaching skills of instructors who know their subject matter can usually be improved to a higher level. Teaching is a skilled activity that takes time and the proper conditions to develop. Developing a *skilled teacher* may take years. The most effective way to develop instructor teaching skills is to provide adequate opportunities to teach under supervised conditions where the observer may analyze inadequacies and provide constructive feedback.

Supervision that strengthens instruction and improves instructor morale has these elements:

- The supervisor and the instructor agree on the specific skills and practices that characterize effective teaching.
- The supervisor observes the instructor frequently to verify that the instructor uses these skills and practices.
- The supervisor and the instructor meet to discuss the supervisor's observations.
- The supervisor and instructor agree on areas for improvement.
- The supervisor and instructor jointly develop a specific plan for improvement.

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FINDINGS ABOUT THE MANAGEMENT OF INSTRUCTION

Training managers must be concerned with the management of their human and material resources. Classroom instructors and instructional developers must be located and trained. Facilities for instruction and instructional materials must be located or developed. Student records must be generated and maintained. This section examines the evidence about how instructional resources can be managed.

41. Planning Change within Organizations

Finding: **Exploiting communications and computer technology can serve policy goals and meet training needs within resource constraints.**

Comments: Many revolutionary changes in communications and computer technologies can be used for instructional purposes with, or sometimes, instead of the teacher, books and manuals, and chalkboards. Various technologies can deliver training that can be as effective or even more effective than current methods. To exploit the advantages of these technologies requires good analysis and planning. The capabilities and effectiveness benefits must be mapped against needs and the current costs of training including training time. Funding must be found for research and development and evaluation of new systems designed to make training more effective and efficient.

The rapid development of new technologies seems to point to the inevitability of significant changes in the way training is accomplished. At the same time, the potential costs of these changes requires caution and a practical outlook. Claims of large benefits in effectiveness must be substantiated by concrete, conclusive empirical evidence. Decades of research reveal that improvements in instructional achievement are usually not due to the communications–computer technology but to redesign of the content. Permitting each student to learn at his own pace achieved with or without computers, is an important source of the gain.

New technology may make possible the delivery of novel forms of instruction where, when, and in ways heretofore impossible, as well as provide delivery of fairly standard instructional matter as needed to students not assigned to schoolhouses. In any case, large scale implementation of training technologies that substantially change the organization and presentation of training should be undertaken only after formal study of its cost effectiveness.

A more focused effort to substantially expand the use of technology in education and attain more fully integrated applications across the curriculum requires new strategies and perhaps decision authority at a level high enough to insure a minimum of interference by those vested in maintaining the established practices and procedures. The

1980s, nevertheless witnessed a tremendous expansion in the use of VCRs and computers. In identifying barriers to increased use of technology, many training directors cite the lack of funds to purchase equipment as a serious problem. When funds are sought, a large initial investment is often necessary to purchase the critical mass of startup equipment. Once the initial equipment has been purchased a steady funding policy is vastly preferable to a hurried "year end" policy. A consistent research finding shows that investments in technology cannot be fully effective unless teachers receive training and support in its use.

The effective use of instructional technology requires an extensive dialogue among instructors and educational researchers. Instructors need to be exposed to, and be part of, new break-throughs in education; researchers need a healthy dose of classroom realities. Classroom trials of new materials is essential to ongoing development and necessary to assess what works. Contributions from many disciplines is required to improve training practices.

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Kearsley, G. (1984). *Training and technology: A handbook for HRD professionals*. Reading, MA: Addison-Wesley Publishing Co.

Nugent, G. C. (1987). Innovations in telecommunications. In R. M. Gagne (Ed.), *Instructional technology: Foundations* (pp. 261–282). Hillsdale, NJ: Erlbaum Associates.

Orlansky, J., & String, J. (1981, Second Quarter). Computer-based instruction for military training. *Defense Management Journal*, 46–54.

Walberg, H. J. (1987, April). Curricular efficiency can be attained. *National Association of Secondary School Principals Bulletin*, **71**(498), 15–21.

42. Managing Instructors

Finding: **Effective training management policies improve instructor training, student performance, and training time management.**

Comments: Successful training managers have an accurate conception of the important factors determining effective instruction. They keep this conception in mind as they interact with personnel and allocate funds. With instructional improvement as a constant theme, they scrutinize existing practices to assure that instructor activities and procedures contribute to the quality of the instructional program. They make sure instructors are trained and participate actively in this process. Effective managers, for example, provide instructors with opportunities to improve their teaching and classroom management skills. They minimize instructors' administrative chores and teaching interruptions, monitor teaching performance, and provide constructive suggestions for improvement.

Effective managers actively support learning. They create an orderly environment, verify that instructors have all the necessary instructional materials and assistance they need, work to raise instructor morale, and create a climate of achievement by encouraging new ideas and involving instructors in policy formation.

Reading List:

Bird, T., & Little, J. W. (1985). *Instructional leadership in eight secondary schools* (Final Report to the U.S. Department of Education, National Institute of Education). Boulder, CO: Center for Action (ERIC Document No. ED 263694).

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Corcoran, T. (1985, May). Effective secondary schools. In R. Kyle (Ed.), *Reaching for excellence: An effective schools sourcebook* (pp. 82–85). Washington, D.C.: U.S. Government Printing Office.

Morris, V. C., Crowson, R., Hurwitz, E., & Porter-Gehrie, C. (1986). Principals in action: The reality of managing schools. Cited in *What works: Research about teaching and learning* (2nd ed., p. 64). Columbus, OH: Charles E. Merrill Publishing Co.

Skinner, B. F. (1984). The shame of American education. *American Psychologist*, **39**(9), 947–954.

43. Managing Student Learning

Finding: **Performance-oriented leadership improves both formal (intentional) and informal (incidental) learning.**

Comments: Managers and instructors are primarily concerned with formal learning developed using systematic procedures designed to promote effective training. However, promoting informal or incidental learning can also further formal instruction. To manage learning effectively both in and out of the classroom, training managers should:

- Assert convictions and philosophies with regard to the importance of learning by each individual.
- Specify the roles for managers and instructors in managing learning and training.
- Specify the role of individual students in managing their learning.
- Personally observe and evaluate the learning environment of schools and their surroundings including: Who is doing what, when, where, and why, and how these actions match their stated philosophy and objectives? How does the physical learning environment affect learning? What is happening in the school that should not be happening?

Example: Adults learn a lot about informal "corporate" life and their jobs outside of the formal presentations in the classrooms. Instructors provide some of this informal training as role models whose incidental behavior the learners observe and adopt. Other students also significantly affect what students learn.

Reading List:

Hill, H., & Sticht, T. (1980, September). *Perspectives on battalion training management (Final Report for USAREUR Field Unit).* Alexandria, VA: Human Research Organization.

Kern, R. (1986). Modeling information processing in the context of job training and work performance. In T. Sticht, F. Chang & S. Wood (Eds.), *Cognitive science and human resources management (Advances in reading/language research, Vol. 4).* Greenwich, CT: JAI Press.

Morgan, M., Hall, D.T., & Martier, A. (1979). Career development strategies in industry: Where are we and where should we be? *Personnel*, **56**(2), 13–31.

44. Monitoring and Tailoring an Instructional System

Finding: **Instruction improves when managers monitor achievement indicators, detects when the value of any indicator moves into an unacceptable range, and then takes focused corrective action (tailoring).**

Comment: Monitoring and tailoring of instructional systems resembles controlling physical systems such as heating or cooling systems. However, the relevant indicators in training systems are less precise than those in physical systems. They must be determined by examining the goals of the schools, the management practices, and objective information about students and instructors.

Training managers can monitor direct and indirect student performance indicators to establish priorities for improving the system. Direct indicators include student attrition and the rate students are "set back" to repeat lessons, and comprehensive and performance test scores. Indirect indicators include student–instructor ratios and background variables. This monitoring requires access to longitudinal records and considerable information processing. With a computer-based information system, managers can identify indicators with values that are in an unacceptable range. Over time, monitoring will reveal if the quality of instruction is being improved.

Focused corrective action or tailoring requires a deployable resource to respond to the indicators. For example, an instructional supervisor or curriculum standards office representative might visit a classroom or school to confirm (or refute) that a problem exists, diagnose the situation, and propose corrective action.

The monitoring and tailoring approach assumes that fine tuning the instructional system can improve the system significantly. The system may require fundamental changes due to changes in technology, resources, or society.

Reading List:

Cooley, W. W. (1983, June/July). Improving the performance of an educational system. *Educational Researcher*, 4–12.

Cooley, W. W., & Lohnes, P. R. (1976). *Evaluation research in education: Theory, principles, and practice.* New York: John Wiley & Sons.

Walberg, H. J. (1984, May). Improving the productivity of America's schools. *Educational Leadership*, **41**(8), 19–36.

45. Physical Classroom Environment

Finding: **Classroom light level, color, temperature/humidity, and noise level control effects student perception, attention, and achievement.**

Comments: Research indicates that in a well designed learning environment a greater level of learning occurs than in a poorly designed educational environment. For temperature variables, an air temperature between 68–70 °F at 30" from the floor for elementary students engaged in sedentary activities, such as reading and writing is a low level heating goal in the winter. For older students, a temperature range of 68–74 °F at 30" from the floor in the winter is healthful and comfortable, if the humidity is kept between 30–60%. The maximum temperature for adult learners for sedentary tasks is 85 °F and 65 °F for active tasks.

Concerning noise factors, noise levels above 96dbA impacted error rates. The noise effects of continuous and intermittent pure tone, noise at fairly low levels, 70dbA, for high cognitive loading tasks results in a significant decrease of learner performance. Background noise apparently interferes with learning or concentration in some learners more than with others. The highest level of background noise in a learning environment should be 45db, with 30db being optimal.

Light levels should be directly related to the viewing difficulty of the learning tasks. Research indicates that insufficient illumination, glare, reflectance, shadows, low brightness contrast, and flickering affect human performance and can be controlled by good lighting and color decisions. For reading tasks, the lighting level should be 540–755 lux; for bench work 540–1000 lux; and for learning rooms (ambient) 500–750 lux. Extreme light level contrast must be avoided, as there is minimal adaptation required for moving from a brightly lit area to a

darker area. Constant adaptation from these varying degrees of light can cause eyestrain and headaches. Research data neither consistently supports claims that windowless classrooms will allow increased concentration and thus higher achievement, nor the fear that the absence of windows will have harmful psychological or physical effects.

It appears that color directly influences individual physiology as measured by blood pressure, respiratory rate and reaction time. Bright, light and warm colors have been shown to initiate outward activities and actions. Cooler, softer colors tend to foster a withdrawal behavior, and a red background generates ideas and actions. A green color is desirable for mediation and for performing tasks. In designing learning environments it is suggested that a variety of colors be used.

Color seems to influence student learning, attitudes, and behavior The impact of color on an individual changes with age and with cultural background.

Color seems to have a direct relationship on an individuals sense of time: red makes most people overestimate time, while greens and blues in the environment cause an underestimation of time. On the other hand, bright colors (such as red) tend to increase an individuals activity level, so consideration of the types of objectives to be taught in an area should be considered in choosing primary classroom or study area colors. Some general guidelines for choosing colors:

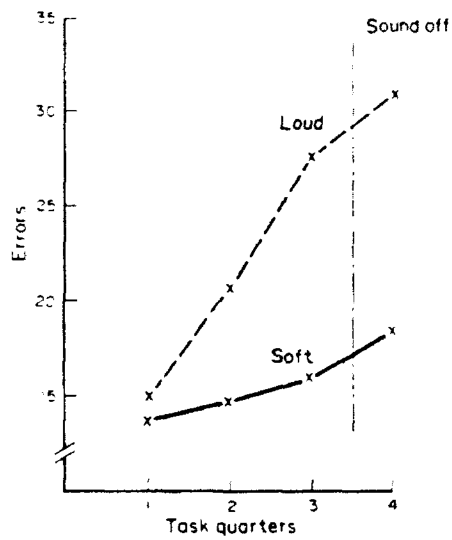
- Classrooms or laboratories: greens, blue-greens, gray, beige.
- Gyms: neutral tones or cool colors.
- Auditoriums: green, aqua, peach.
- Entry areas: pink (also useful in prison holding tanks to quiet prisoners), or neutral tones.

Changes in classroom colors can affect learners. Changing the focus area, or changing individual attitudes, in a classroom may also be done by painting the classroom a light neutral color and then using flood-lights to change the setting.

Lighting seems to have a profound biological effect on humans. Both the quantity and quality of light are important. Natural, full spectrum tubes (as opposed to traditional fluorescent tubes), reduces individual stress and aggression, yet seems to be more intellectually stimulating. While light level preferences differ among individuals, bright lighting seems to increase student achievement for most students, but students preferring low lighting did better under lower light conditions; a learning environment apparently should not be uniformly bright and

students should be allowed to sit where their light preferences direct them. Guidelines for various types of activities can be found in the references provided below.

Example: Many experiments have been conducted studying the effects of noise on sustained attention. The figure below illustrates the effects of noise on the incidence of errors over time in a serial reaction task lasting 40 min. Precautions to eliminate the effects of acoustic cues were taken which included the use of a silent keyboard and ear defender headphones. In both loud (90dbC and soft 60dbC) conditions the noise is switched off at the end of the third quarter.



Reading List:

Dunn, R. *et al.* (1985). Light up their lives: A review of research on the effects of light on children's achievement and behavior. *Reading Teacher*, **38**(9), 863–869.

Knirk, F. G. (1979). *Designing productive learning environments*. Englewood Cliffs, NJ: Educational Technology Publications.

Knirk, F. G. (1987). *Instructional facilities for the information age*. IR-76. Syracuse, NY: ERIC Clearinghouse on Information Resources.

Sanders, M. S., & McCormick, E. J. (1987). *Human factors in engineering and design* (6th ed.). New York: McGraw-Hill Book Co.

Jones, D. M., & Broadbent, D. E. (1987). Noise. In G. Salvendy (Ed.), *Handbook of human factors*. New York: Wiley & Sons.

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46. Managing Informal Learning

Finding: **A focus on the management of learning can improve incidence and quality of informal learning in training environments.**

Comments: Individuals obtain much of their knowledge and skills outside of formal school settings. Some informal learning is negative such as learning poor work habits from the examples of others. Managers can influence informal learning of students by:

- Applying environmental designs for learning: for example placing posters with critical information in mess halls, hallways, and other places where sailors spend time. Messages should be designed for ease of learning, motivation, and creating awareness;
- Promoting learning requirements for off-time during watch standing, placing learning materials in job/duty sites, requiring reading of job and training materials when on-duty during slack periods, and verifying that the assignments are done;
- Encouraging all personnel including individual sailors to think: dedicating "read and think" time during duty hours for personnel to think about what they do and how to do it better.

Reading List:

Hall, D. T., & Fukami, C. V. (1979). Organization design and adult learning. *Research in Organizational Behavior*, **2**, 125–167.

Hill, H., & Sticht, T. (1980, September). *Perspectives on battalion training management* (*Final report USAREUR Field Unit*). Alexandria, VA: Human Resources Research Organization.

Kern, R. (1986). Modeling information processing in the context of job training and work performance. In T. Sticht, F. Chang & S. Wood (Eds.), *Cognitive science and human resources management (Advances in reading/language research, Vol. 4)*. Greenwich, CT: JAI Press.

Morgan, M., Hall, D. T., & Martier, A. (1979). Career development strategies in industry: Where are we and where should we be? *Personnel*, **56**(2), 13–31.

Rogoff, B., & Lave, J. (1984). *Everyday cognition: Its development in social context*. Cambridge, MA: Harvard University Press.

47. Student Instructor Ratio Tradeoffs

Finding: **Increasing moderately large student–instructor ratios in basic courses has little effect on student learning. Enlarging class size frees existing instructors for alternative laboratory training, tutoring, or counseling activities.**

Comments: Small student–instructor ratios tend to promote frequent interactions between students, instructors, and materials. Students in small classes have more interest in learning, achieve more, have a somewhat better self-image, and have a better quality of interaction between student and teacher than do students in large classes. Teachers in small classes may have higher morale. In colleges, where classes are fairly large, both instructors and students prefer smaller classes, but larger classes do not affect student academic achievement. When class size is more than about a dozen or so students, there are fewer opportunities for students to participate in discussions. In lecture presentations, class size makes hardly any difference because students are already passive and interactions are minimal. Therefore, for basic, "academic" training courses, class size — unless below 10 or so students — does not affect student learning until it gets large enough to prevent students from seeing or hearing the instruction.

Changing instructor–student ratio enables managers to manage their instructor resources in ways that can improve student learning. Instructors now relieved from presenting duplicate or repetitive courses can prepare other presentations, interact with students individually or in small groups, conduct laboratory exercises, or evaluate and revise existing courses.

Individualized instruction and small group instruction have different characteristics than does large group instruction. Large group instruction normally relies on an instructor to present organized materials; usually with a "lesson plan" or with "instructional media." Many studies of class size indicate that a reduction of a large class of 30 to 15 or 20 would have little or no impact on student achievement. Conservatively stated, the addition of a student, or two, or three to a class that is over, perhaps, 7 students in size, will not demonstrably affect the quality of a class.

Individual student feedback and individualized student instruction typically are limited to less than a minute per classroom session; a minute to each student in a classroom of twenty students would require 20 min.

Laboratory-based instruction does seem to decrease in quality as class size increases as the instructors role in most laboratory sessions is one of performing individual student assessment and guidance.

Small group and individualized instruction, in most courses, does result in higher student achievement and affect than large group instruction. Teacher roles in these groupings allows a greater range of teaching strategies, better classroom management, and permits more attention to student classwork and homework. The relatively high instructor costs in these groupings often makes them prohibitively expensive for the measurable, but slight increase in student achievement.

Reading List:

Odden, A. (1990). Class size and student achievement: Research-based policy alternative. *Educational Evaluation and Policy Analysis*, **12**(2), 213–227.

Robinson, G., & Wittebols, J. H. (1986). *Class size research: A related cluster analysis for decision making*. Arlington, VA: Educational Research Service.

Slavin, R. (1989). Achievement effects of substantial reduction in class size. In R. Slavin (Ed.), *School and classroom organization*. Hillsdale, NJ: Erlbaum.

Williams, D. D., Cook, P. F., Quinn, B., & Jensen, R. P. (1985). University class size: Is smaller better? *Research in Higher Education*, **23**(3), 307–18.

A TWO PHASE EVALUATION OF "WHAT WORKS: A SUMMARY OF EDUCATIONAL RESEARCH AS IT RELATES TO ADULT LEARNING"

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Introduction

There are many approaches to the evaluation process, but the most essential component is gaining knowledge from the end-users themselves. How this is accomplished can be a variety of ways, such as usability laboratories, on-site and field evaluation, observations, and questionnaires. The method to be used is determined by: (1) the resources (e.g., money, laboratory space, filming equipment) that are available, (2) the geographic location of the users, and (3) the availability of trained evaluators. Each approach has particular strengths and provides the evaluation team or individual with information in which to analyze, plan and redesign and redevelop the product or system. As defined by Sohm and Bertrand (1988), the evaluation process is a tool which managers, trainers, and designers can use to emphasize the facilitative dimension and iterative process of evaluation. They further state that evaluation is a learning and action-oriented management tool. Evaluation is a process for determining as systematically and objectively as possible, the relevance, effectiveness, and impact of activities and products in the light of their objectives in order to improve both current activities, products, systems, and provide for future planning, programming, and decision-making (Sohm & Bertrand, 1988).

Purpose

The intent of this paper is two-fold: One, to describe the evaluation process of the document "What Works" and second, to demonstrate the measured value and

significance of the "What Works" document. The evaluation process was broken into two phases. Phase one occurred one year after the development of the "What Works" document, and Navy personnel were the surveyed users. Phase two occurred two years after the "What Works" document was published and included Navy personnel, University professors and Technical College instructors. Each evaluation phase used a separately developed questionnaire in order to attain pertinent data concerning the value, use, significance, and future of the "What Works" document. Both questionnaires employed quantitative questions as well as qualitative questions which required written responses and comments from the users.

Using both qualitative and quantitative questions for attaining information from the users provides a type of content validity for the surveys. Thus, with these types of multiple measures the reliability and validity of the responses to the survey can be assumed to be reasonably high. The objective of this evaluation process was to gain knowledge and feedback from the users regarding the valuable use and significance of the "What Works" document. This evaluation process is considered to be a formative evaluation as knowledge that was gained from the first evaluation procedure was incorporated into the enhancement and development of the newly revised second "What Works" document. With the passage of time, and expanding the user group to non-military settings, allowed the developers of "What Works" to further incorporate and integrate new suggestions and ideas into the document.

Methodology

Evaluation Procedure for Phase I

The original distribution of the "What Works" document was primarily to Navy personnel, specifically training executives, training specialists, and instructors. A year after the initial distribution, a questionnaire was developed to survey these users about the usefulness and likelihood of use of the "What Works" document. The developed questionnaire was mailed to these users and a response rate of 45% was attained. The total sample size for this survey was 40 training executives, 37 training specialists, and 39 instructors for a total of 116.

Survey Instrument for Phase I

The first evaluation questionnaire for phase I was comprised of seven questions. Three questions were a Likert four point scale with room to provide additional comments. Four questions were open ended questions requiring written responses.

The scoring of the questionnaire consisted of percentage distributions for the first three questions. For the open ended questions, the responses were content analyzed according to the appropriate user classification, that is for training executives, training specialists, and instructors. Additionally, tables were developed incorporating the trainers responses regarding the index that was provided in the "What Works" document. This index is provided at the beginning of the document and is broken into the three occupational

categories of training executives, training specialists, and instructors. Cross-referencing the users responses with this index was conducted.

Evaluation Procedure for Phase II

After "What Works" was developed and distributed to the appropriate Navy personnel, many requests were received from other trainers of adults. A copy of the "What Works" was sent to these individuals. As the list of mailings to universities, technical trade colleges, and various military branches geographically located throughout the United States and overseas (Australia and the United Kingdom) enlarged, it was decided to evaluate again the effectiveness of "What Works" on this expanded population. The total sample size and distribution was the following: Military personnel, *n* d 18, technical colleges, *n* d 2, universities, *n* d 3, totaling 23.

Survey Instrument for Phase II

The evaluation questionnaire for phase II constituted of seventeen questions. This questionnaire focused on the use of the "What Works" document, organization and style of the document, value and significance of the document and several questions on the future application and use of the document. There were fourteen questions that required a yes/no response with room for comments. Three questions that were developed are on a five point Likert scale and again, there was room for responses from the users. At the end of the questionnaire there was room for general comments concerning the "What Works" document.

The scoring of the ;' ase II questionnaire consisted of calculated percentages for the yes/no responses, frequency ratings for the questions concerning the organization, the value or significance, and the writing or readability of the "What Works" document. For the open ended responses and comments, content coding was employed and organized for these qualitative measures.

Results

Phase I Evaluation of "What Works"

For determining the usefulness of the "What Works" document a distribution of the reported percentages is presented in Figure 1.

This figure illustrates, for each Navy training specialization—training executive, training specialist, and instructor—that overall the "What Works" document was regarded as very useful. For the training executives, more than 40% reported that the "What Works" document was useful. Over 50% of the training specialists indicated that the "What Works" document was useful, and this result was consistent for the training instructors. Depicted in Table 1 are the ratings from all three training users

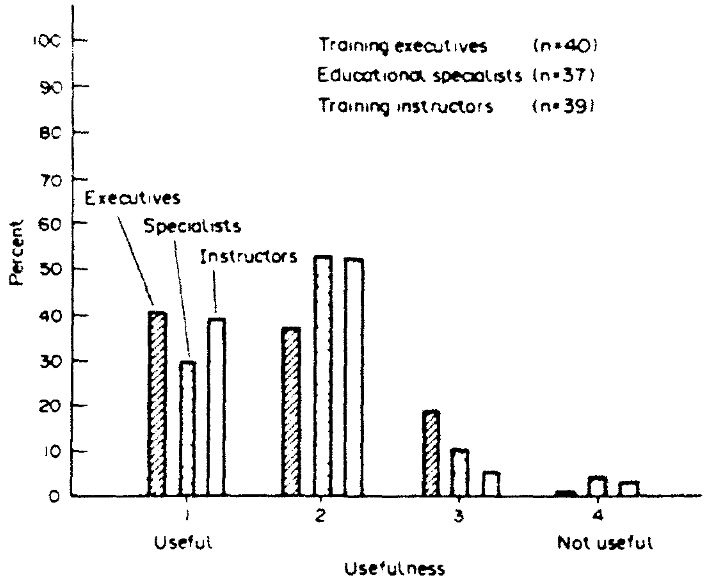

Figure 1. Percent of usefulness of "What Works" for all three training groups [phase-1 evaluation]

Table 1
Training Evaluators Range of Usefulness for Training Instructors as Indicated by "What Works" Instructor Index [Phase-1 Evaluation]

"What Works": Number of evaluators citing index items for training instructors as most useful or least useful (question 1)						
Evaluators range of usefulness	Most useful			Least useful		
Index for training instructors	*E	*S	*I	*E	*S	*I
[01] Instructor classroom role	1	1	11			1
[02] Instructor classroom leadership		1	10			1
[03] Teaching students how to learn	1		13			
[04] Promote development of mental models		1	3			4
[05] Motivating students	1		8			
[06] Cooperation in learning			6			2
[07] Student control of learning			5		1	7
[08] Instructor presentation stimulates learning			9			
[09] Managing class time				1		1
[10] Practice			3			2
[11] Peer teaching			10			16
[12] Out-of-class assignments			1			8
[13] Testing student learning	1		4			1
[14] Giving feedback to students			11			
[15] Rating instructors			4			2
All of the above topics (01–15) found useful	3	12	11			

*E d Training executives (*n* d 40).
*S d Educational specialists (*n* d 37).
*I d Training instructors (*n* d 39).

concerning the usefulness of the document with regards to the "What Works" index that is presented in the front of the document.

Some of the comments that were given by the users concerning the usefulness include the following: "the body of work is a valuable resource and reference document." and "it is a highly informative and enlightening document."

Figure 2 presents the percentage distribution for the likelihood of using the "What Works" document.

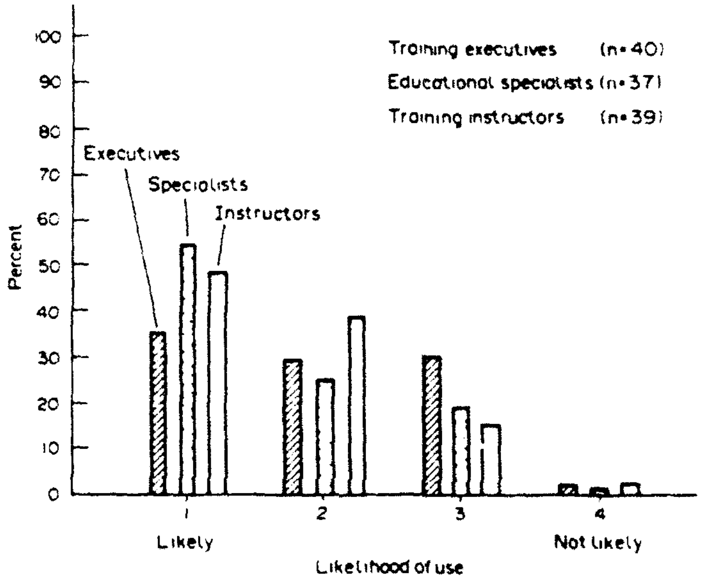

Figure 2. Percent of likelihood of use of "What Works" for all three training groups (phase-1 evaluation).

More than 55% of training specialists and instructors rated the likelihood of use very high. The percentage of training executives rating the use of the document was lower than the specialists and instructors, by approximately 35%. The open ended comments supported the high use of the document for the specialists and instructors as many of them indicated that they would use it for in-service training, as a reference document, as a baseline for developing training curriculum as well as for instructor courses.

Depicted in Figure 3 is the percentage of familiarity of the material that was presented in the "What Works" document.

It appears that the material was mostly familiar to the training executives and specialists as opposed to the training instructors. Shown in Table 2 are the evaluators grouped comments for each of the trainer types reflecting a more detailed expression of how the document "What Works" was familiar to the evaluators.

Some of the open ended comments regarding the familiarity of "What Works" were the following: (1) "May be familiar with "What Works" findings, but the document updated my knowledge and provided me with new references and resources." (2) "some new

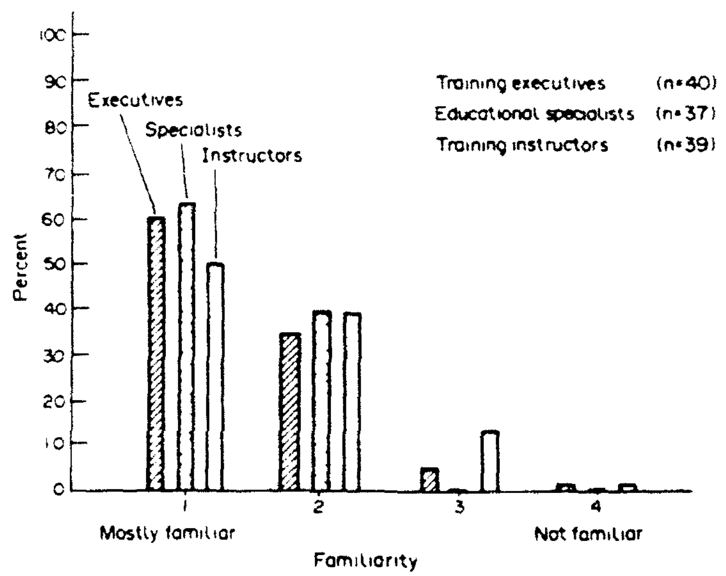

Figure 3. Percent of familiarity of "What Works" topics for all three training groups [phase-1 evaluation].

Table 2
Training Evaluators Content Coding for Open Ended Responses Regarding Familiarity of "What Works" Topics for all Three Training Groups [Phase – 1 Evaluation]

"What Works": Number of evaluators grouped comments for what is familiar in What Works (question 3)

Evaluators grouped comments	Trainer types *E	*S	*I
[01] Yes in IT school, yes familiar, yes instructor basic	7	4	20
[02] Most basic, common sense		4	1
[03] Specifics not known, some new ideas, common but unwritten	1	2	2
[04] Only aware, if not school grads not known, expands info	3	4	
[05] Very new, new concepts, new terms, specialist index new		1	3
[06] Implemented, teach now	1		1
[07] Lacks implementation		1	
[08] Computer info is new		1	1

*E = Training executives (n = 40).
*S = Educational specialists (n = 37).
*I = Training instructors (n = 39).

concepts were presented, especially with new training technologies," and (3) "aware of the basic concepts, but an applied research approach was presented."

Question number four on the first evaluation questionnaire was an open ended question requiring a written response. These comments were subsequently content coded for each type of training professional. Table 3 depicts the "What Works" document index

Table 3
Training Evaluators Indications of Areas that may be Applied to Improve Training for "What Works" Index for Training Executives [Phase-I Evaluation]

"What Works": Number of evaluators citing index items for executives that might be tried and applied to improve training (question 4)

Index for training executives	Trainer types *E	*S	*I
[01] School learning environment		2	
[02] Managing instructors	2	3	
[03] Evaluating and supervising instructors	3	3	1
[04] Managing student learning	2	2	
[05] Monitoring and tailoring an instructional system	2	2	
[06] Course evaluation and revision	2	4	
[07] Imitating the working environment for learning	1	1	3
[08] Maintaining skills and knowledge	1		1
[09] Students-instructor ratio tradeoffs	1	1	
[10] Managing informal learning	1	1	
[11] Planning changes in conducting training	3	1	
[12] Cost effectiveness	1	1	
[13] Structuring instruction	2		
[14] Computer-based instruction	2	1	2
[15] Video technologies for instructing	5	1	1
[16] Training devices for task simulation and practice	2		1
[17] Distributed instruction		1	
[18] Adopting training innovations		1	1
All of the above topics (01–18) will try to be applied	3	2	3

*E = Training executives (n = 40).
*S = Educational specialists (n = 37).
*I = *Training instructors* (n = 39).

specifically for training executives and their reflections of how the document results might be applied to improve training considering each type of trainer category, i.e., executives, educational specialists, and instructors.

A few of the more frequently mentioned comments include: "planning changes in conducting training," "evaluating and supervising instructors," "course evaluation and revision," and "video technologies for instruction."

Similar to question four, question five was another open ended response item. This question specifically asked the trainer professional to list any ideas on how the "What Works" document may be used in a training environment. The most frequent responses were organized according to each trainer type and are shown in Table 4.

A few of the comments included: (1) "Instructor training and indoctrination," (2) "planning changes in conducting training," (3) "evaluating and supervising instructors", and (4) "course evaluation and revision."

Table 5 shows various responses for each training professional concerning research summaries that could be useful in a future document of "What Works."

The most frequent responses were: (1) Case studies, (2) updating and including new research, (3) examples and extensive references, (4) cross-referencing of findings, and

Table 4
Training Evaluators Content Coding for Open Ended Responses on How the "What Works" may be Used for all Three Training Groups [Phase I Evaluation]

"What Works": Number of evaluators grouped comments that listed ideas on how the document may be used (question 5)

Evaluators grouped comments	Trainer types		
	*E	*S	*I
[01] IT school	4	1	5
[02] Instructor indoctrination. 1st session. training. workshops. handouts	17	8	9
[03] Control directives		1	
[04] Reference. guide. refresher	6	9	12
[05] Inservice. with visuals. req'd reading. GPI school	3	3	8
[06] Expand topics			1
[07] Survey of schools		1	
[08] New staff. managers. discussion groups	4	6	1
[09] CNET. CNTECHTRA	2		
[10] Instructor evaluation. monitor. training. feedback. academic skills	1	3	2
[11] Seminar			1
[12] Get more executives involved	1		
[13] Video	1		
[14] Design of instruction	1	1	
[15] Semi-annual performance counseling		1	
[16] Distribution implemented	2	1	1

*E = Training executives (n = 40).
*S = Educational specialists (n = 37).
*I = Training instructors (n = 39).

(5) broad dissemination of "What Works" and mandating the document in all instructor training courses.

Phase II Evaluation of "What Works"

Percentages of yes/no responses were calculated for twelve of the fixed response questions for the second evaluation questionnaire of "What Works." Table 6 presents these percentages for the appropriate phase II evaluation questionnaire.

A 74% yes response rate was reported for using the "What Works" document. A variety of uses were indicated by the training professionals and users as provided in the comment section. Some of the more interesting comments include: (1) "Planning for research in skill retention," (2) "understanding perceptual motor skills and skill decay," (3) "used as a format for developing videoteletraining", (4) "used as a baseline, starting point to develop training as well as a checklist for training," (5) "use of tasks/functions for managers/instructors on what they should be concerned with," (6) "used in graduate training. instructions courses as a general reference document for my graduate and teaching assistants," and (7) "used in my cost/benefit analyses."

The frequency rating for the value and significance of the "What Works" document is illustrated in Figure 4.

Table 5
Training Evaluators General Comments for Other Future Research Summaries for all Three Training Groups [Phase-1 Evaluation]

"What Works": Number of evaluators grouped comments on listing other potential future research summaries (question 6)

Evaluators grouped comments	Trainer types		
	*E	*S	*I
[01] AV materials. CNET support. IT school. new schoolhouses. tech availability	5	1	1
[02] External appraisal. instructor evaluation. prerequisite position training		3	
[03] Examples. more info. extensive references. U.S. Dept ED 1986	2		1
[04] ASVAB research. research on specifics. specific info	1		2
[05] Training aids. lecture. practice examples. instructor index 1.2.3	1		2
[06] Research on specific rating skills. latest research	1		1
[07] Spacing instruction. keeping standards consistent		1	1
[08] Latest automated technology. controlled research feedback technology	2		
[09] Survey of schools. research on application. impact study skills	1	1	1
[10] More fleet update after graduation. feedback from fleet			2
[11] Attrition analysis. history. demographics		1	1
[12] Case studies. case study deviations/time	1	1	
[13] Research on retention. retest. skill retention. retention termination	1	3	3
[14] Include in IT basic			1
[15] Multiple choice tests. tests. analyze. evaluate		1	1
[16] References from AEG. NPRDC. ACR follow-up critiques		1	1
[17] Conference summaries specific problems		1	
[18] CBI versus NON-CBI job performance	1		
[19] Library. tech manuals. in rate pubs			1
[20] Design lab sessions	1		

*E = Training executives (n = 40).
*S = Educational specialists (n = 37).
*I = Training instructors (n = 39).

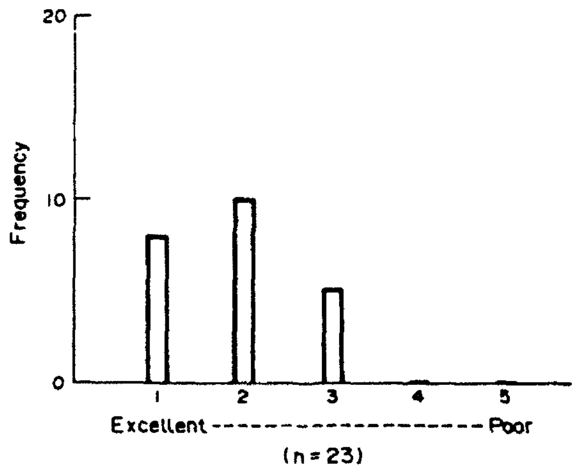

Figure 4. Frequency rating for value or significance of "What Works" [phase-2 evaluation].

Table 6
Summary of Percentages of Questionnaire for Phase-2 Evaluation of "What Works"

Findings of the second evaluation questionnaire of "What Works" percentage that agree (yes) vs. disagree (no)

	Survey questions [phase-2 evaluation]	% Yes	% No	N
(1)	Did you receive the NPRDC "What Works"?	91%	09%	23
(2)	Have you received other research summaries similar to What Works?	17%	83%	23
(3)	Did you use What Works?	74%	26%	23
(5)	Did you have any problems in using What Works?	05%	95%	20
(7)	In What Works document, would the use of examples be helpful?	91%	09%	22
(8)	Would directions on using What Works be helpful?	36%	64%	22
(10a)	Do you have any personal experiences (examples, procedures etc.) that could be included or added to the document of What Works?	18%	82%	22
(10b)	Could we use your example(s) in a future What Works?	80%	20%	5
(11)	Are there additional topics that you feel should be added to What Works?	53%	47%	19
(13)	How or where do you think an updated version of What Works should be published?	100%	00%	13
(14)	Would an electronic or on-line message system be useful in conjunction with What Works?	55%	45%	20
(15)	Would having a help line or a specific contact person for assistance be useful?	70%	30%	20
(16)	Would a hypertext or similar software program be useful for locating research and disseminating the What Works conclusions?	71%	29%	17

N = Number of subjects answering the question (possible $n = 23$).

As shown, 18 training users rated the significance of the document as very good to excellent. Various comments were provided by the training professionals including statements such as "excellent piece of work and extremely helpful," "assisted us in developing curriculums for the real world," "nice dissemination of applied research and examples to complement the theoretical research," "useful tool and nice cross-referencing with theoretical and applied research," and "most comprehensive review I have seen yet."

A very low percentage was reported for having any difficulty or problems in using "What Works." The strength of the organization of the "What Works" document is illustrated in Figure 5.

Twenty-one training users rated the organization of "What Works" as very good to excellent. One user commented that the "What Works" document was a "great dissemination of works and well organized considering the board area of training and learning material that it included."

The frequency ratings concerning the writing style, readability and clarity of the "What Works" document is illustrated in Figure 6.

Nineteen training professionals rated the writing style and readability of the document as very good to excellent. One training professional user wrote "the writing style of the "What Works" document was refreshing as it avoided the use of technical and nonsense jargon."

All of the evaluators unanimously (100%) stated that publishing an updated version of "What Works" at least every two years would be beneficial. In updating the

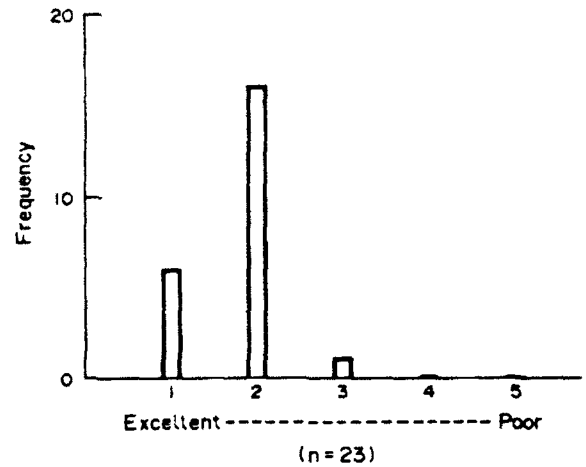

Figure 5. Frequency rating for organization of "What Works" [phase-2 evaluation].

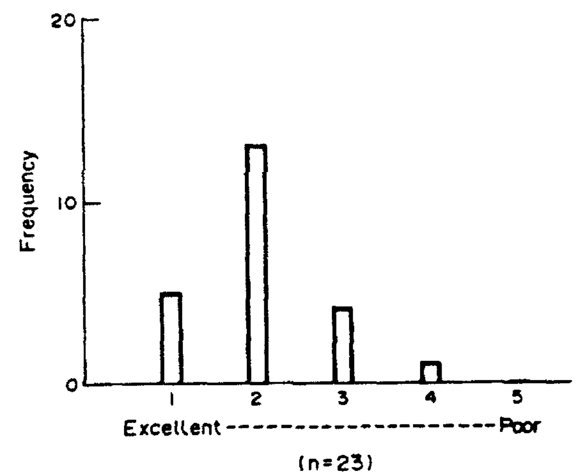

Figure 6. Frequency rating for writing style/readability clarity of "What Works" [phase-2 evaluation].

document new references and resources could be added as well as keeping training professionals appraised with new research, trends, and solutions in the training field, especially considering applied training research. Furthermore, additional topics or expanding current topics that potentially could be incorporated into future "What Works" documents were provided by the training user evaluators. Some of the topics elicited include: (1) Team training and evaluation, (2) new research on instructional technologies, (3) evaluation of training and cost/benefit analyses, (4) techniques for developing and validating test materials, (5) approaches for effective transfer of training, (6) 1 or 2 detailed case studies of how to, and cross referencing to the appropriate material in "What Works," and (7) bibliography of meta-analyses and literature reviews.

Questions which focused on the future application and use of "What Works" indicated some interesting percentages (i.e., questions 14, 15, 16). One result was the issue of providing an on-line message system. A corresponding 55% response rate was reported by all types of training professional. Furthermore, 70% of the respondents indicated that they would like to have a specific contact person for assistance concerning the application and use of the findings presented in the "What Works" document. Some of the comments provided by the training evaluators and users concerning the necessity of having a point of contact were: (1) "Would be helpful as an additional resource/assistance to the document," (2) "establish a continuous contact could be helpful to facilitate the development and need for additional topics," (3) "helpful as it would assist us since we don't have the experience and resources", and (4) "a e-mail system could possibly extend the access to the "What Works" document and possibly provide for on-line help."

Regarding the presentation format of "What Works," over 70% of the trainer users reported that developing a hypertext system for "What Works" would be useful as cross-indexing and word searching would be more efficient, effective, and helpful. Additional comments provided by the training professionals were that they would like to have a hypertext format as it would allow for the ability to cross-reference and index. However, one limitation to this presentation format was noted by several training users involving the availability and cost of computer systems which could be prohibited in some situations. Also, many users commented that with the hard copy document they had the ability to pass it around to other colleagues and could study it for a longer period of time.

Two general comments that were provided by the training users in the open ended comment section regarding the "What Works" document were: (1) "The document was a fine contribution to the education and training field," and (2) "I found the document such a valuable reference and resource that I have ordered 25 more copies."

Discussion and Concluding Remarks

This two phase evaluation process has been successful in gaining information from the end-user who is the training professional in this case. Using questionnaires to survey the end-users has provided the developers of the "What Works" document with valuable information and feedback regarding the usefulness, value, organization, and relevant topic selections of the document. With this type of formative evaluation process, further development and enhancement of the "What Works" was accomplished and its effectiveness was further measured by the phase II evaluation questionnaire. Moreover, using quantitative and qualitative measures in assessing the effectiveness of the "What Works" document provided multiple data points and a type of cross content validation.

It does appear that the "What Works" document is useful as well as being a significant body of work that is valued by a varied training population. Many training professionals reported a high satisfaction with the value of the document and its usefulness in planning, designing, and developing instructional curriculum in diverse learning environments. Furthermore, the organization and writing style was well received and rated high by a significant portion of the training users. Even though there was a high percentage of

reported familiarity with the material presented in the document, many users further clarified that the document contained new references, resources, and linkages between theoretical and applied research in the instructional and training settings.

Future presentation formats and topics were explored and it appears that many training users would like to see a hypertext format as it would provide them with the capability to cross-reference and index instructional and training topics. Also, having the capability to access via e-mail could provide the training professional with needed assistance and potential reference sources in developing and evaluating their training curriculums. Providing an updated "What Works" document every two years was noted by many training users. This would allow for incorporating new training strategies and research findings, especially in the area of new training technologies. Additional topics could also be added and incorporated and integrated into the overall organization of the topic indexes. Providing new and relevant case studies, possibly from some of the end-users themselves, with cross-referencing to the summaries and index in the "What Works" document was reported frequently by the training professionals.

This two phase evaluation process provided the "What Works" developers with the necessary information in order to further enhance and expand the document as well as demonstrating the measured value and significance of the "What Works" document. As indicated by the end-users, the training professional, this document is a worthwhile, valuable resource summary of educational research in the planning, designing, and developing of instructional and training curriculums for the adult learner.

References

Sohm & Bertrand (1988). *Glossary of evaluation terms*. Joint Inspection Unit, Geneva, Switzerland.

Distribution List

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